SOME LIMNOLOGICAL FEATURES OF AL-HAMMAR MARSH SOUTH OF IRAQ AFTER RESTORATION

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ABSTRACT:
Some Limnological features (electrical conductivity, pH, salinity, dissolved oxygen, water temperature, light penetration, turbidity, nutrients NO_2, NO_3, PO_4) were used in current study to monitor Al-Hammar marsh (Al-Naggarah and Al-Burgah) south of Iraq monthly sampling for one year. The mean range of the following limnological parameters were recorded: water temperature ranged between 11.1 to 33 C°, electrical conductivity ranged between 2453.3 to 6100 µs/cm, salinity ranged from 1.16 to 3.3 ‰, pH ranged between 7 – 8.6, water depth ranged between 0.7 to 1.9 m, light penetration ranged from 70 to 200 cm, dissolved oxygen ranged from 3.67 to 10.03 mg/l, NO_2 ranged from 0.11 to 3.393 µg/l, NO_3 ranged between 0.69 to 16.466 µg/l, PO_4^{-3} ranged between 0.5 to 21.95 µg/l. According to the results, Al-Hammar marsh is rich in nutrients which can enhance their suitability for growing aquatic plants and phytoplankton. Seasonal variations and some fluctuations were observed in this marsh during different seasons for both sites. The results of this study initiate significant background information and database for physico-chemical variables of Al-Hammar Marsh.-

Key words: Limnology, Physico-chemical, nutrients, marshes.

بعض الصفات اللمنولوجية لهور الحمار جنوب العراق بعد اعادته

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المستخلص
استعملت بعض الخصائص والصفات اللمنولوجية كالتوصيل الكهربائي والاس الهيدروجيني والملوحة والأكسجين المذاب ودرجة حرارة الماء واختراق الضوء والعكورة والمغذيات (NO_2 وNO_3 وPO_4) واخذت عينات شهرية لمدة سنة واحدة في هذه الدراسة لمراقبة هور الحمار من محطتين (النگارة والبرگة) ضمن اهوار جنوب العراق. تراوحت القيم المسجلة لكل من القياسات التالية درجة حرارة الماء بين 11.1 الى 33 سيليزي وتراوحت قيم التوصيل الكهربائي بين 2453.3 الى 6100 µs/cm، وتراوحت نسبة الملوحة بين 1.16 الى 3.3‰، درجة الاس الهيدروجيني بين 7 الى 8.6، عمق المياه تراوح بين 0.7 الى 1.9 متر، وتراوحتقيم اختراق الضوء بين 70–200 سم، فيما تراوحت قيم الأوكسجين الذائب بين 3.67 الى 10.03 ملغم/لتر، وتراوحت قيم النتريت بين 0.11 الى 3.393 ميكروغرام/لتر، وسجلت قيم النترات مدى بين 0.69 الى 16.466 ميكروغرام/لتر، واخيرا سجلت قيم الفوسفات مدى بين 0.5 الى 21.95 ميكروغرام/لتر. ووفقا لنتائج الدراسة، كان هور الحمار غني بالمواد المغذية التي يمكن أن تعزز نمو النباتات المائية والهائمات النباتية. وقد لوحظ تغيرات الموسمية وبعض التقلبات بوضوح في هذه الأهوار خلال المواسم المختلفة لكلا الموقعين. تُعد نتائج هذه الدراسة معلومات أساسية هامة وقاعدة بيانات للمتغيرات الفيزيائية والكيميائية لهور الحمار.

الكلمات المفتاحية: المياه العذبة، الصفات الفيزيائية والكيميائية، المغذيات، الاهوار.

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INTRODUCTION

Water is one of the important and abundant compounds of the ecosystem, and has ability to dissolve many of organic and inorganic compounds (15). Unique freshwater wetland ecosystems that are the Iraqi marshes, the Mesopotamia Marshes were one of the largest wetlands in the Middle East and Western Eurasia (25). The Iraqi marshlands, which are known as the Garden of Eden, cover a big area in the lower of the Mesopotamian basin where the Tigris and Euphrates Rivers flow (2). Iraqi marshes are the most extensive wetland ecosystems in the Middle East (8). Much the largest wetlands are the Al-Hammar and its associated marshes (350,000 ha) south of Euphrates; the central marshes (300,000 ha) a vast complex of permanent lakes and marshes north of the Euphrates and west of the Tigris. In Mesopotamia, one of the most serious threats has been the drainage and diversion of water, as typically supply for agricultural use, recently, for military reasons (25). Physical and chemical properties are very important to determine quality of water and to compare with the standard values (10). An important role that water quality plays in terms of restoration southern Iraqi marshes (7). Water is highly polluted with different harmful contaminants because of increasing human population, industrialization, fertilizers and man-made activity (19). Qualitative and quantitative measurements are necessary to monitoring water quality of various supplying sources. Water quality indices are tools to determine conditions of water. Most studies are focused on the physico-chemical characteristics, as well as the ecological aspects previously (1, 13) and later (5, 6, 8, 14, 23). This study is designed to monitor some limnological features of Al-Hammar marsh south of Iraq after restoration.

MATERIALS AND METHODS

STUDY AREA

Al-Hammar Marsh is located south of the Euphrates, extending from near Nasiriyah in the west of Basra on Shatt Al-Arab River in the east. To the south, saline lakes, sabkhas, and the sand dune belt of the southern desert borders the marshes. Maximum depth at low water levels is 1.8 m and about 3m at high water mark (16). For the purpose of this study 2 stations (sites) were selected {Al-Naggarah (North 31° 40′3.7″ East 47° 38′ 37.8″) & Al-Burgah (North 31° 41′ 17.8″ East 47°′23.9″) in Al-Hammar marsh (Fig. 1)}.

METHODS

Water sampling was collected from the 2 studied sites (Al-Nagarah and Al-Burgah) of Al-Hammar marsh monthly (Fig. 1) starting from November 2006 to October 2007. Some limnological field measured features are water temperature W T, EC, pH (were measured using a Multi 340i instrument), Salinity, DO dissolved oxygen (using Azid modification method), turbidity (using Multi 340i instrument), light penetration LP (using Secchi Disc), all the environmental variables were determined according to (9), whereas for nutrients (NO_2, NO_3) using Cadmium Column, and (18) for measuring PO_4^{-3}. Pearson's Product Moment Correlation Coefficient (r) was used to determine the correlation value between environmental variables, as well as, mean, standard error were employed.

Fig. 1. The studied sites in Al-Hammar Marsh (Al-Naggarah and Al-Burgah).

RESULTS AND DISCUSSION

Tables (2 and 3) shows that the water temperature in both of the studied sites were highest during summer (maximum 33 C° in August in Al-Naggarah) and lowest during winter (minimum 11.1 C° in January 2007 in Al-Burgah site). There were no differences recorded between the temperatures of the two sites and between the temperatures at the surface and within the water column. The reasons for this is because of the marshes are shallow waters and the seasonal variations in water temperature ranged between 11.9 to 33

C°, the temperature recorded lower value in January 1988 at Al-Hammar marsh (1, 13). Present study showed that the water electrical conductivity values for both two sites in Al-Hammar marsh ranged between 2453.3 to 6100 µS/cm and water salinity values ranged between 1.16‰ to 3.3‰, the lowest values for both electrical conductivity and salinity were recorded in Al-Naggarah site during August 2007, whereas the highest values were in Al-Burgah site during March 2007 (Figures 3 and 4). The seasonal changes in water electrical conductivity and salinity values were clear, the maximum values were in winter and spring seasons, while either the minimum values were in summer season, it could be concluded that the value of conductivity is within the productive range (17) and the marshes of southern Iraq could be considered as a productive water body, so that the study area is considered Oligohaline according to Reid's classification (21, 26) referred to that water of Iraqi marshes were either Oligohaline or Brackish water. Water electrical conductivity and salinity have negative highly significant correlation with water depth, nutrients (NO_2^-, NO_3^-, and PO_4^{-3}), light penetration, and dissolved oxygen (Tab. 1). pH values ranged from 7 to 8.6 for both studied sites, that showed clear seasonal variations, where the maximum values were in the fall, winter, and spring seasons, while the minimum values were in summer season, in the studied sites, that may related to phytoplankton productivity. The low pH values recorded in Al-Naggarah site during September 2007 (Tab. 2; Fig. 5) that may be due to the degradation of the aquatic plants, phytoplankton and organic materials, also production of dissolved carbon dioxide (3, 5, 23), while the high pH values recorded in Al-Burgah site during March 2007 (Tab. 2), this result agreed with the results of other researchers (3, 5, 6, 14, 23), that was because declining of carbon dioxide concentration and increasing the alkaline ions (11). It has being known that the Iraqi waters mainly tend to be natural to slightly alkaline. From the statistical analysis (correlation coefficient) water pH has highly significant negative correlation with water temperature, NO_3^-, and PO_4^{-3}, while has highly significant positive correlation with the rest parameters (Tab. 1). During the study period, water depth ranged from 0.7 to 1.9 m, the lowest value was recorded in the Al-Nagarah site during March 2007 (Tab. 2; Fig. 6), and the highest value (1.9 m) was recorded in Al-Naggarah site during April 2007 (Tab. 2). The light penetration values throughout the study period ranged between (70 – 200) cm, the lowest value was recorded in Al-Burgah site during March 2007 (Tab. 3; Fig. 6), while the highest recorded in Al-Naggarah site during June 2007 (Tab. 2). Al-Naggarah Marsh water was characterized by transparence that due to marsh water is shallow most of study period, and Al-Burgah marsh was little bit turbid, these results agreed with the previous studies about Mesopotamian marsh (6). Light penetration has highly significant negative correlation with salinity, water depth, and PO_4 (Tab. 1). The results of this study shows that the dissolved oxygen values for both studied sites were between (2.67 – 10.07) mg/l, when the lowest value was (2.67 mg/l) in Al-Burgah site during July 2007 (Tab. 3), while the highest value was (10.07 mg/l) in Al-Nagarah site during January 2007 (Tab. 2). Seasonal changes in dissolved oxygen values during the study period were clear, the maximum values were in the winter season with decreasing temperature, while the minimum values were in the summer season (Fig. 7), in the studied sites; that may be due to the increasing of photosynthesis by phytoplankton and aquatic plants and to the big surface water area which let ability for best mixed and more oxygen compensation from atmosphere (20), as well as, that the dissolved oxygen content of water is influenced by the source, raw water temperature, treatment and chemical or biological processes taking place in the distribution system. Depletion of DO in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide. No health-based guideline value is recommended (28). These results are consistent with the findings of many studies that have been conducted by (3, 5, 6, 22, 23), they found that the values of DO were high in overall the marshes, which reached to 12.21 mg/l, except some rare places in which lower values (1.67 mg/L). A negative relationship between water temperature and water salinity with dissolved oxygen was obtained, it was found throughout the results, based on the correlation, in addition that dissolved oxygen has highly significant negative correlation with salinity, electrical conductivity, water temperature, chlorophyll-a, and total count; whereas highly significant positive correlation with oxygen saturation rate, NO_2, water depth, and pH (Tab. 1). It should be noted that nutrient availability and phytoplankton biomass fluctuate widely on a range of time scales from days to seasons to years. Nutrient bioassays are useful indicators as to which nutrient has the potential or is likely to limit phytoplankton growth at a particulate time and space (24). Nitrites values for the present study ranged between (0.11- 3.393 μg/l), were the lowest value was in Al-Naggarah site during December 2006 (Tab. 2; Fig. 9), while the highest value was in Al-Burgah site during August 2007 (Tab. 3; Fig. 9). Nitrates values for the present study ranged between (0.69- 16.466 μg/l), were the lowest value was in Al-Burgah site during March 2007 (Tab. 3), also Al-Burgah site recoded the highest value during September 2007 (Tab. 3). The increases in values may be due to their releases from sediment surfaces, while the decreases in nitrates due to the growth of aquatic plants and phytoplankton's as they could be seen in the sites and because of the majority of these plants, nutrients are decrease in the water of marshlands (12). The results of this study clearly showed seasonal changes in NO_3^- concentration during the study period, when the maximum values were in summer season, while the minimum values were in winter season, that's mean they have two peaks in winter and summer during the study period (Fig. 10), in addition to widely fluctuations in their values which may due to that marsh water affected by water coming from neighbor agricultural fields which in enriched with nitrogen fertilizers. While the higher concentrations in summer is probably due to the bacterial activity and the decomposition of organic compounds associated with the high temperatures. On the other hand, the decreasing of NO_3 was mostly due to increase in growing of the aquatic plants during this period as well as the higher water column in this marsh (13). Table 1 shows that water NO_3 has highly significant positive correlation with water depth, water temperature, NO_2, and PO_4, while has highly significant negative correlation with electrical conductivity, salinity, pH, and dissolved oxygen. Nitrates were higher than nitrites along the whole study period and were higher during the study period may due to the dead aquatic plants that covering the area and then decomposed by decomposers that leading to increase the nutrients among which are the nitrates, as well as the shallow nature of the marshes during its early stages of rehabilitation leading to increase the nutrients (1). Seasonal variation in nitrate and nitrite concentrations agreed with (5, 6, and 23). According to (12), after rehabilitation and water returned to the marshlands, quantities of nutrients began to liberate from sediments to water column. The results of this study shows that reactive phosphate values during the study period ranged between (0.5 - 21.95 μg/l), the lowest value was in Al-Burgah site during November 2006 (Table 3), while the highest value (21.95 μg/l) was recorded in Al-Naggarah site during August 2007 (Tab. 2). Higher concentrations of phosphate values in summer and fall seasons were mostly due to the decomposition of aquatic plants and organic matter. Decreasing water level, and the high phosphate concentrations may have contributed to the suspended particulate matter may observed during these two seasons as phosphorus may come from dust, fine soil particles, and fertilizer from agricultural fields, while the lower PO_4^{-3} concentrations in autumn and winter may result due to the dilution of the water by rainfall and flooding, in addition to the increased uptake by aquatic plants during these two seasons (27). Orthophosphate in the present study was found in rather low concentrations were similar to the studies performed by (5, 23). Whereas the seasonal variations showed that PO_4^{-3} concentrations were high in summer and spring and low in autumn and winter (Fig. 11), this disagreed with the results obtained (9) as they reported high PO_4^{-3} concentrations during summer and autumn and lower PO_4^{-3} concentrations in winter and spring. Table1 shows that water PO_4^{-3} has highly significant positive correlation with water depth, water temperature, light penetration, DO, NO_2, and NO_3; while highly negative significant correlation with electrical conductivity, pH, and salinity. The values reported in this study for Nitrates, Nitrites and Phosphates are greater than all previous studies may due to high sediment contents of organic matter resulted from decomposition of aquatic plants as well as other organisms which decomposed after the desiccation of marshlands (4).

Table 1. Correlation matrix of environmental variables

	W. T.	pH	Sal. ‰	E.C. (μs/cm)	W. D. (m)	L.P.	DO	NO_2	NO_3	PO_4
W.T	1									
pH	-0.6635	1								
Sal. ‰	0.0703	0.0703	1							
E.C. (μs/cm)	0.1616	0.0212	0.5384	1						
W.D. (m)	-0.0457	0.0623	-0.3063	-0.2089	1					
L.P.	-0.0843	0.0437	-0.3989	-0.0113	0.3184	1				
DO	-0.6896	0.5245	-0.2185	-0.2687	0.3217	0.1708	1			
NO_2	-0.0750	0.0573	-0.5462	-0.3583	0.2819	0.1879	0.2588	1		
NO_3	0.3135	-0.3321	-0.3854	-0.2490	0.2560	0.0873	-0.0769	0.4746	1	
PO_4	0.2668	-0.1844	-0.5595	-0.2214	0.2454	0.2675	0.1809	0.3844	0.4145	1

Table 2. Monthly variations of environmental parameters in Al-Naggarah site / Al-Hammar Marsh during study period. (Mean ± & standard error)

Months	W.T C°	E.C. μs/cm	Sal. ‰	pH	W. D. m	L. P. Cm	DO	NO_2 (μg/l)	NO_3 (μg/l)	PO_4^{-3} μg/L
Nov.06	13.2 ± 0.00	3850 ± 0.00	1.9 ± 0.00	8.046 ± 0.0088	1.00 ± 0.00	140 ± 0.04	4.72 ± 0.44	0.13 ± 0.00	13.66 ± 0.416	3.836 ± 0.616
Dec.06	11.2 ± 0.00	4203.3 ± 3.333	2.1 ± 0.00	8.12 ± 0.00	1.5 ± 0.00	100 ± 0.00	8.96 ± 0.22	0.11 ± 0.00	3.67 ± 0.28	2.266 ± 0.666
Jan. 07	13.8 ± 0.00	4970 ± 0.00	2.1 ± 0.00	8.2 ± 0.057	0.75 ± 0.00	135 ± 0.02	10.07 ± 0.36	1.15 ± 0.00	5.37 ± 0.978	3.943 ± 0.556
Feb. 07	16.63 ± 0.066	5321 ± 0.577	2.7 ± 0.00	8.55 ± 0.0033	1.61 ± 0.005	160 ± 0.03	9.62 ± 0.94	2.39 ± 0.00	1.02 ± 0.37	1.6 ± 0.05
Mar.07	17.4 ± 0.00	5946.6 ± 3.33	3.2 ± 0.00	8.1 ± 0.0033	0.7 ± 0.00	125 ± 0.22	5.88 ± 0.27	1.44 ± 0.09	1.15 ± 0.28	6.11 ± 1.11
Apr.07	23.7 ± 0.057	4170 ± 145.71	1.8 ± 0.00	8.2 ± 0.152	1.9 ± 0.00	190 ± 0.04	6.48 ± 0.29	1.48 ± 0.081	1.71 ± 0.33	4.883 ± 0.861
May07	25.3 ± 0.057	3050 ± 0.00	1.5 ± 0.00	7.56 ± 0.033	1.6 ± 0.00	180 ± 0.09	4.89 ± 0.25	0.386 ± 0.096	0.75 ± 0.09	10.5 ± 0.00
Jun.07	28.36 ± 0.266	3646.6 ± 3.33	1.8 ± 0.00	7.23 ± 0.166	1.2 ± 0.00	200 ± 0.22	3.91 ± 0.41	1.496 ± 0.56	4.98 ± 1.27	2.88 ± 0.721
Jul.07	29.00 ± 0.00	3780 ± 5.77	1.9 ± 0.00	7.63 ± 0.033	1.6 ± 0.00	140 ± 0.04	3.24 ± 0.23	0.566 ± 0.103	14.43 ± 3.25	19.71 ± 2.534
Aug.07	33.00 ± 0.00	2453.3 ± 3.33	1.16 ± 0.033	7.34 ± 0.0033	1.8 ± 0.00	125 ± 0.11	3.8 ± 0.33	2.766 ± 0.306	2.75 ± 0.11	21.95 ± 1.15
Sep.07	29.7 ± 0.00	2900 ± 0.00	1.4 ± 0.00	7.00 ± 0.00	1.9 ± 0.00	100 ± 0.05	4.9 ± 0.351	0.406 ± 0.126	7.54 ± 0.446	4.833 ± 0.482
Oct.07	27.4 ± 0.00	3276.66 ± 3.33	1.6 ± 0.00	7.60 ± 0.0033	1.6 ± 0.00	90 ± 0.04	5.8 ± 0.46	0.76 ± 0.21	4.24 ± 0.21	13.0 ± 0.964

Table 3. Monthly variations of environmental parameters in Al-Burgah site /of Al-Hammar Marsh during study period. (Mean ± & standard error)

Months	W.T C°	E.C. µs/cm	Sal. ‰	pH	W. D. m	L. P. Cm	DO	NO_2 (µg/l)	NO_3 (µg/l)	PO_4^{-3} µg/L
Nov.06	15.3 ± 0.00	3970 ± 0.00	2 ± 0.00	8.01 ± 0.086	1.00 ± 0.00	75 ± 0.04	3.04 ± 0.36	0.963 ± 0.146	14.08 ± 1.1	0.5 ± 0.00
Dec.06	11.2 ± 0.00	4203.33 ± 3.333	2.1 ± 0.00	8.37 ± 0.003	1.2 ± 0.00	100 ± 0.00	7.51 ± 0.31	0.36 ± 0.19	2.64 ± 0.19	4.933 ± 0.666
Jan. 07	11.1 ± 0.00	4680 ± 0.00	1.9 ± 0.00	8.13 ± 0.066	1.5 ± 0.00	75 ± 0.02	9.01 ± 0.43	0.95 ± 0.1	9.64 ± 0.88	2.83 ± 0.00
Feb. 07	16.83 ± 0.033	5371.3 ± 0.881	2.8 ± 0.00	8.45 ± 0.005	1.8 ± 0.003	100 ± 0.03	9.03 ± 0.93	3.39 ± 0.00	0.83 ± 0.00	1.6 ± 0.00
Mar.07	19.3 ± 0.00	6100 ± 0.00	3.3 ± 0.033	8.6 ± 0.0033	1 ± 0.00	70 ± 0.22	6.53 ± 0.67	0.531 ± 0.09	0.69 ± 0.09	6.666 ± 0.961
Apr.07	23 ± 0.1	4153 ± 31.79	2 ± 0.00	7.95 ± 0.028	1.85 ± 0.00	100 ± 0.04	6.83 ± 0.61	1.34 ± 0.275	0.975 ± 0.045	4.516 ± 0.429
May07	24.7 ± 0.173	3050 ± 0.00	1.5 ± 0.00	7.66 ± 0.033	1.6 ± 0.00	75 ± 0.09	3.15 ± 0.15	1.76 ± 0.340	0.76 ± 0.00	10.5 ± 0.721
Jun.07	26.73 ± 0.33	3463.3 ± 3.33	1.7 ± 0.00	7.53 ± 0.033	1.2 ± 0.00	90 ± 0.22	2.75 ± 0.11	1.39 ± 0.11	3.39 ± 0.56	6.36 ± 0.721
Jul.07	28.3 ± 0.00	3863.3 ± 3.33	2 ± 0.00	7.6 ± 0.00	1.3 ± 0.00	90 ± 0.04	2.67 ± 0.23	1.473 ± 0.532	15.61 ± 1.95	18.88 ± 3.145
Aug.07	31.83 ± 0.166	2570 ± 00.0	1.2 ± 0.00	7.34 ± 0.012	1.7 ± 0.00	75 ± 0.11	2.8 ± 0.22	3.393 ± 0.461	2.56 ± 0.00	14.16 ± 2.94
Sep.07	28.7 ± 0.00	3000 ± 0.00	1.5 ± 0.00	7.2 ± 0.00	1.3 ± 0.00	75 ± 0.05	3.25 ± 0.31	1.48 ± 0.00	16.466 ± 1.683	6.776 ± 0.553
Oct.07	27 ± 0.00	5376.6 ± 3.33	1.8 ± 0.00	8.27 ± 0.005	0.75 ± 0.00	90 ± 0.04	3.9 ± 0.2	1.59 ± 0.178	6.116 ± 0.273	9.66 ± 1.92

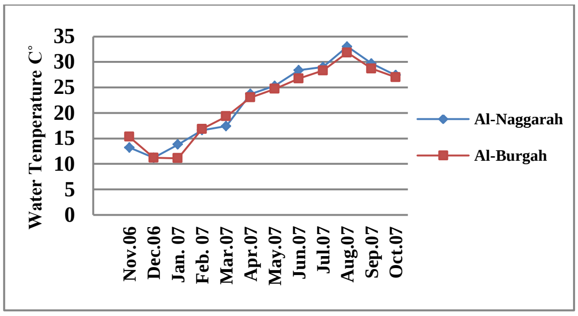

Figure 2. Monthly variations in water temperature degrees for the two studied sites in Al-Hammar Marsh

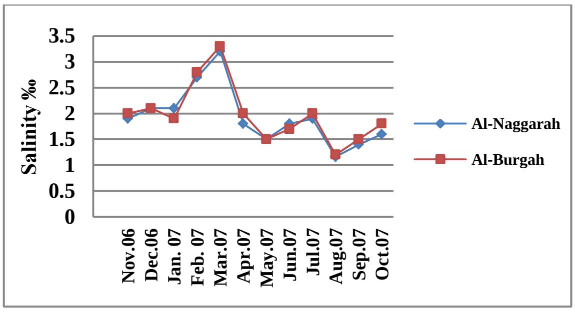

Figure 4. Monthly variations in salinity values for the two studied sites in Al-Hammar Marsh

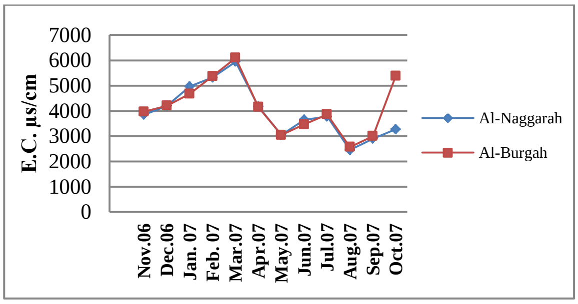

Figure 3. Monthly variations in electrical conductivity values for the two studied sites in Al-Hammar Marsh

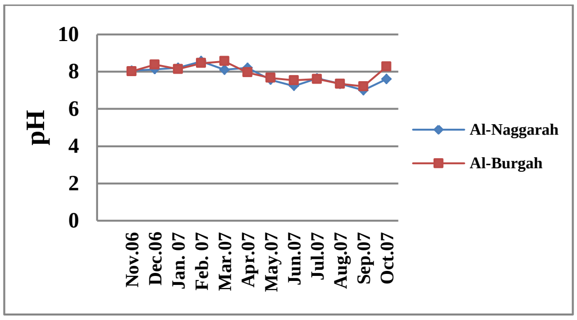

Figure 5. Monthly variations in pH values for the two studied sites in Al-Hammar Marsh

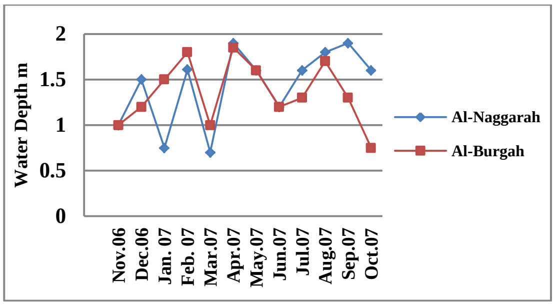

Figure 6. Monthly variations in water depth values for the two studied sites in Al-Hammar Marsh

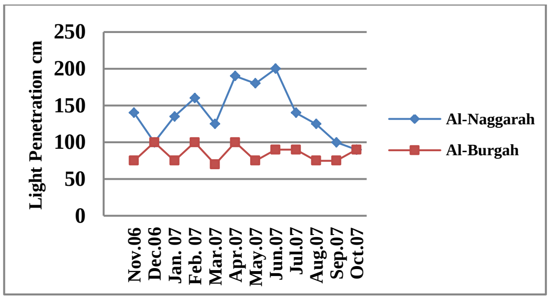

Figure 7. Monthly variations in light penetration values for the two studied sites in Al-Hammar Marsh

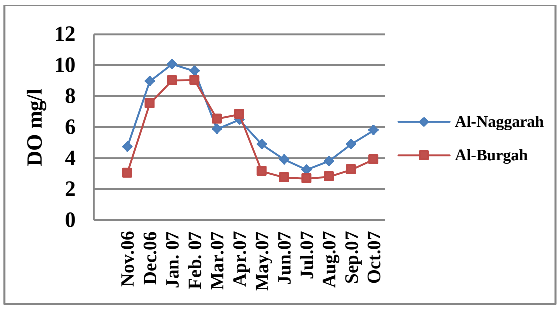

Figure 8. Monthly variations in (DO) values for the two studied sites in Al-Hammar Marsh

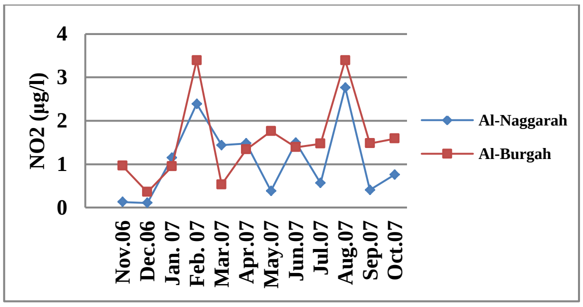

Figure 9. Monthly variations in NO_2 values for the studied sites in Al-Hammar Marsh

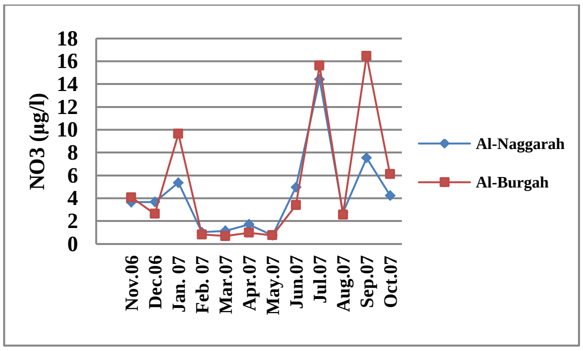

Figure 10. Monthly variations in NO_3 values for the two studied sites in Al-Hammar Marsh

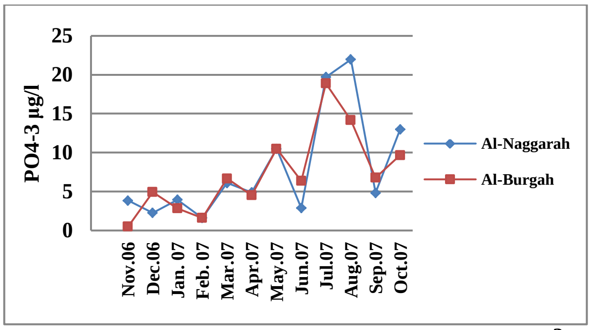

Figure 11. Monthly variations in $PO4^{-3}$ values for the two studied sites in Al-Hammar Marsh

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