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Water quality of the Iraqi southern marshes

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Abstract - After inundation, water quality surveys were designed and implemented during November 2005 to September 2006 at six locations, 4 in the Hor Al-Hammar (Al-Barga, Al-Nagara and Al-Baghdadia 1 and 2) the other 2 locations in Hor Al-Hwaaiza (Um Al-Warid and Um Al-Neiach). The sampling locations were selected to cover the distribution of the pollutants in these marshes. Physical and chemical stressors including the natural water quality parameters, dissolved oxygen (DO), biological oxygen demand (BOD), turbidity, total suspended solids (TSS), total dissolved solids (TDS), electrical conductivity (EC), total hardness (TH), temperature, salinity and pH as well as nutrients were studied. The mean range of the following parameters were recorded: pH (7.56-7.84), EC (1.29-3.22 mmohs/cm^2), Ca (87.18-130.26 mg/l), Mg (60.35-111.17 mg/l), Cl (304.7-753.31 mg/l), TSS (11-38.58 mg/l), TDS (891-2040.42 mg/l), DO (5.16-10.05 mg/l), turbidity (4.57-39.03 FTU), salinity (0.53-1.7 ppt), water temperature (21.09-22.47 C°), air temperature (23.54-35.26 C°), SO4 (285.73-663.89 mg/l), HCO3 (204.39-255.22 mg/l), and TH (481.67-777.5 mg/l). These marshes are also rich in nutrient especially nitrate and phosphate which enhance their suitability for growth and billings of aquatic plants and phytoplankton. Also the seasonal variation of all the parameters were monitored during this study, and the result showed some fluctuation in some of them during different seasons at different locations of the marshes. The results obtained during this survey established important background information and a baseline for further restoration work and indicate reasonable signs of successful restoration.

Introduction

The Iraqi marshes are freshwater wetland of unique ecosystem. The biome mostly include plants, and many animals, which inhabit this rich environment. The values of the plants are numerous, including rich flora and fauna, livestock grazing field, fish and other wildlife breeding places. The marshes are also known to be farmland for rice, and cultivation areas for some other crops. Species lists, classification, specific characteristics, water chemistry and some physical factors of the area can be sought in a number of studies, which some are listed in the references or has been referred to elsewhere in the text.

The marshes are crucial ecosystem, which influences, and also are influenced by many natural forces and human activities. They are crucial as incubators for fish and invertebrates, and play a vital role as habitat for majority of waterfowl. On the other hand, they are a critical factor in the complex web of life for both Shatt-Al-Arab Estuary, the Gulf, and the surrounding land ecosystems. It is, therefore, very important that the remaining marshes be protected and that their health enhanced wherever possible. This is important for the surrounding environment, and for people who share this part of Iraq, in particular.

The marshes of the middle and lower basin of the Tigris and Euphrates River in Iraq are the most extensive wetland ecosystems in the Middle East. In their lower courses, these two great rivers have created a vast network of wetlands, which is known as Mesopotamian marshes, covering about 15,000 to 20,000 sq. km. These wetlands comprise of interconnected shallow freshwater lakes, marshes and seasonally swamped floodplains extending from the region of Basrah to within 150 km of Baghdad. Winter rains in the headwater of the Tigris and Euphrates in southern Turkey, Syria cause extensive flooding throughout Mesopotamia and fill up the lake system in the south. Water levels reach their maximum in early spring and then fall by as two meters during the hot dry summer. Much the largest wetlands within this complex are the Hor Al-Hammar and its associated marshes (350,000 ha) south of the Euphrates; the Central Marshes (300,000 ha) a vast complex of permanent lakes and marshes north of the Euphrates and west of the Tigris; and Hor Al-Hawizah and its associated marshes (220,000 ha) extending east the Tigris into neighboring Iran.

These wetlands eventually drain southeastward into the Gulf via the Shatt-Al-Arab Estuary. This vast area of marshland is the home of many species of aquatic plants, fish and water birds. The most serious threat to the wetland in Iraq has been the drainage of wetlands and diversion of water supplies for agriculture purpose and, apparently also in recent years, for military reason. Dam building on the Euphrates in Turkey and Syria and the increasing utilization of the waters of Tigris and Euphrates for irrigation in the upper and middle Iraq have greatly reduced the extent of seasonal flooding in the wetlands of lower Iraq, and facilitated drainage of large areas for cultivation and exploitation of oil resources. Before the desiccation of southern Iraqi marshes, little attention has been given to these marshes for the studies concerning water quality.

Most studies were focused upon the physical and chemical parameters, as well as ecological aspects (Al-Saadi *et al*., 1981, Al-Saadi and Al-Mousawi, 1988, Al-Arajy, 1988, Al-Zubaidi, 1985, Al-Lammi, 1986, Qassim, 1986 and Al-Saad and Al-Timari, 1993). A field study was initiated to assess the extent and magnitude of water quality threats of the marshes of southern Iraq. This study was carried out involving 6 fixed stations, 4 in the Hor Al-Hammar (Al-Barga, Al-Nagara and Al-Baghdadia 1 and 2) the other 2 locations are in Hor Al-Hwaiza (Um Al-Warid and Um Al-Neage). The sampling locations were selected to cover the distribution of the pollutants in these marshes. Physical and chemical stressors including the natural water quality parameters, nutrients, DO, BOD, turbidity, TSS, TDS, EC, temperature, salinity and PH were studied. The physical and chemical aspects of the water provide valuable indications of the overall health of the ecosystem of the marshes. The result obtained during this survey established important background information and a baseline for further restoration work in the southern marshes of Iraq.

Materials and Methods

Water samples were collected monthly, for the period from November 2005 to November 2006. This study was carried out involving 6 fixed stations as shown in Fig. (1), four in the Hor Al - Hammar (Al-Barga, Al-

Nagara and Al-Baghdadia 1 and 2) the other two locations are in Hor Al-Hwaiza (Um Al-Warid and Um Al-Neiage).

Parameters like air and water temperatures were measured by simple thermometers with a range of 10-100˚C graduate at 0.2˚C, pH was measured using pH meters model HANNA HI-9821.Electrical Conductivity (EC) was measured using portable digital conductivity meters (WTW 3301). TDS, TSS, HCO_3 and SO_4 were analyzed according to the standard method given in AOAC (1984), while the rest of parameters such as BOD, DO, TH, Mg, Ca and Cl were analyzed according to APHA (1999) standard method. Nutrient (NO_3, NO_2, PO_4, SiO_4) were measured by using Parson *et al.* (1984) methods.

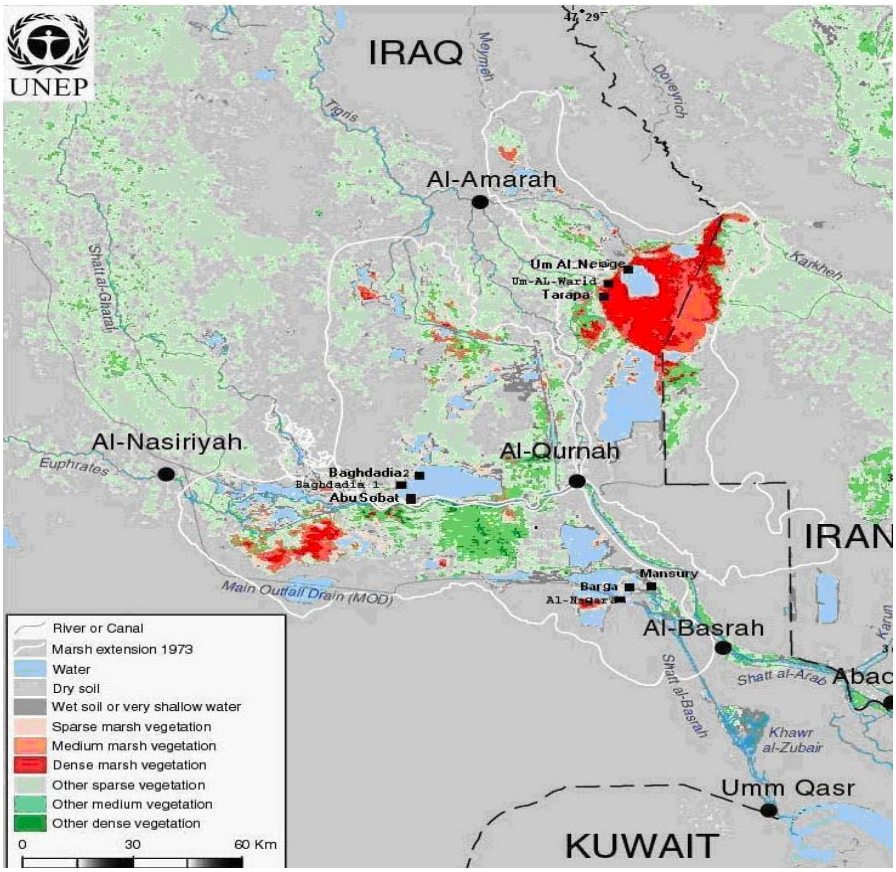

Figure 1. Map of the southern marshes of Iraq showing sampling locations.

Results and Discussions

Results of the present study showed that the air temperature in all stations were high during summer and low during winter (Tables 1, 3, 5, 7, 9, and 11). At Al-Baghdadia 1 it ranged from 12.0 - 38.8˚C (Table 2). In Al-Baghdaida 2 the range was from 14.8 - 36.4˚C (Table 4). In Al-Barga the

range was from 14.0 – 33.0˚C, in Al-Nagara the range was from 12.0 - 34.0˚C, in Um-Al-Neiage the range was from 16.5 - 40.3˚C and in Um Al-Warid the range was from 17.4 -39.0˚C (Tables 2, 4, 6, 8, 10 and 12), respectively. Seasonal water temperature ranged between 11.9 and 33˚C, lower temperature down to 9.9˚C was recorded in January 1988 at Al-Hammar marsh (Al-Aaraji, 1988 and Hassen, 1988). No differences were recorded between the temperature at the surface and lower layers within the water column due to shallowness of the water in the marshes (Maulood *et al*., 1979).

The pH of water is another important factor influencing the species and metabolism of organisms inhabiting. Fishes are relatively poor regulators of internal PH, thus, changes in the PH of their environment can alter enzyme activities or electrolyte composition of the body fluid and provide sever stress. Low pH interferes with the oxygen uptake, and pH outside a range of 4-10 can kill fish (Mattews, 1998). Therefore, the study of this factor is essential. During the study period the pH in all sites were higher in winter and spring than in summer and autumn (Table 4). The existence of huge plants growth leads to consumption of CO_2 gas during winter and spring which in turn lead to increase the pH. The lower value was recorded in Al-Bagdadia 2, the lower mean value was 6.6 and higher mean value was 8.76. The maximum pH recorded in the present study is slightly greater than those recorded. This may be due to the removal of carbon dioxide from the water by the photosynthesis of phytoplankton, and removing of hydrogen ions in response to photosynthesis, hence raising the pH. The pH has a unique value occurred in the basic side between 7 and 8.5 as those for other Iraqi waters due to the gypsum nature of the bottom and soil of the marshes. Antoine (1983) and Al-Kaisi (1979) recorded values of pH down to 6.5 in water from certain sites in the marshes. They explained those levels on the basis of formation and accumulation of organic acids due to incomplete decomposition of living organism residual. On the other hand, Al-Zubidy (1985) has recorded high pH values up to 9.13 in Al-Qurnah marshes and explained that on the basis of increased phytoplankton in the area.

The determination of dissolved oxygen is essential the minimum value was 1.4 mg/l, and the maximum value was 12.4 mg/l which were recorded in Al-Baghdaida 2 (Table 4). Also the minimum mean values of dissolved oxygen were recorded during summer at stations Al-Baghdida 1, and 2, Al-Barga and Al-Nagara (Tables 1, 3, 5 and 7), because as the temperature increases the oxygen holding capacity of water decreases, which means that temperature plays a major role in the biological processes. The same conclusion was reached by Al-Lami (1986) he found the values of DO were high overall the marshes, which reached 11.95 mg/l, however, there are some rare places as in Qurna marshes in which lower value as 1.67 mg/l was recorded by (Al-Zubidy, 1985). Complete absence of dissolved oxygen in this area is expected due to decomposition of residual plants and animals (Al-Saad and Al-Timari, 1994). The total alkalinity of the waters of Southern Iraqi Marshes was ranged between 97 (in Al-Baghdadia 2) and 396 mg $CaCO_3$ mg/l (in Um-Al-Neiage). Higher values were recorded during winter and spring and lower levels were recorded during summer and autumn in

Um-Al-Neiage (Tables 9 and 11), Alternative values in total alkalinity were found in different sites of the marshes, the same conclusion was previously reached by Al-Aaraji (1988), Al-Sayab (1989), and Abed (1989). It can be concluded that the water of the marshes is moderately high alkaline and suitable for raising fish.

Results from the present work showed that the value of Electrical Conductivity (EC) ranged from 0.984 in UM-Al-Warid to 4.94 cms/cm in Al-Baghdadia 1 (Tables 12 and 2), respectively. In Hor Al-Hwaiza in two locations, higher EC were observed during spring and autumn than in winter and summer (Tables 9 and 11) while in the other marshes high values were observed during summer season than in winter (Tables 1, 3, 5 and 7). Low values of conductivity could be attributed to the dilution of salts due to rainfalls. From the present data and those reported by earlier workers (Al-Arajy, 1988 and Al-Zubaidi, 1985), it could be concluded that the value of conductivity is within the productive range and the marshes of southern Iraq could be considered as a productive water body.

The salinity of the water in this area is affected by two main factors, first, the quantity of water interring the area in which salinity records were lower during the period April–June (Pankow and Huq, 1979), while higher values were recorded during low water level time, September-November (Arndt and Al-Saadi, 1975), second, high temperature during summer and autumn lead to high evaporation in addition to the semi arid nature of the area with very low rain, salinity will increase during that period of the year. During the 1980, increasing salinity emerged as another serious threat to the wetlands, particularly in the southeast portion of Hor Al-Hammar. In 1980, the salinity in the Shatt Al-Arab at Qarmat Ali was around 0.5 ppt. This has now changed drastically, with values of more than 2ppt being recorded in recent years, and the water become more saline. One of the contributing factors is likely been the linkage of the southern part of Hor Al-Hammar (at Qarmat Ali) to a new canal, the "Al-Basrah Canal", which runs parallel to the Shatt Al-Arab into Khor Al-Zubair and finally to the Arabian Gulf. This canal was constructed during the Iraq-Iran war to provide a safe shipping line between Basrah and the Gulf. Another reason for the increase in salinity is the continuous flushing of salt from irrigated land via drainage canals into the wetland. Much of the waste water is discharged into the mouth of Al-Basrah canal and thus enters Hor Al-Hammar. During the later years, increased constructions of dams and basins led to decrease levels of water interring the marshes which in turn led to increase the salinity of the marshes. Value reported was up to 6.33 ‰ in Hor Al-Hammar (Al-Rekabi, 1992), an extreme high value recorded in Hor Al-Hammar was 21.45 ‰ by Al-Zubidy (1985). Latter on, the values were reduced after the construction of the third river. The present study showed that the minimum value of salinity (0.2 ppt) was observed in Hor Al-Hwaiza at UM-Al-Neiage (Table 10) while the maximum value was observed at Al-Baghdadia I (2.6 ppt) in Hor Al-Hammar (Table 2).

Levels of suspended materials were reported to be low in the marsh waters, they ranged between 1.3 and 4.4 gm/l in October 1987 and August 1988 at Hor Al-Hammar (Al-Aaraji, 1988), which are very low compared to Tigris, Euphrates and Shatt Al-Arab (Al-Saad and Al-Timari, 1994). The

reason was explained on the basis of thick plant cover which play a major role in precipitation of suspended matter quickly in addition to high water level during the period of the study, our result showed that the minimum value (2mg/l) of TSS was observed in Hor Al-Hammar at Al-Baghdadia 2 (Table 4), while the maximum value was observed at Um-Al-Warid (7 mg/l) (Table 12), also variations were observed during different seasons at all the sites of marshes.

Salt dissolved in water is another important factor. Waters of the marshlands of Iraq were hard to very hard (Reid, 1991), ranges of total hardness were between 452.33–1339 mg $CaCO_3$ mg/l. Lower values were observed in Al-Baghdadia 1 and in Um-Al-Warid (200 mg/l) (Tables 2 and 10), while maximum value was observed in Al-Barga (1140 mg/l) (Table 6). Most of the higher values were observed during winter season in all the sites except in Al-Baghdadia 1 (Table 6),
in which high value was observed during autumn. Spatial variations in total hardness showed large differences among different sites in the marshes, the same conclusion have been arrived by Al-Arajy (1988), Al-Zubaidi (1985), Al-Lammi (1986), Qassim (1986) and Hassen (1988). However, minimum values of calcium and magnesium were recorded (48.09 and 19.44 mg/l) at Al-Baghdadia 1, respectively and maximum values (248.5 and 238.14 mg/l) in the same areas, respectively (Table 2). The seasonal values of Ca and Mg in Hor Al-Hammar at Al-Baghdadia 1 and 2, showed lower concentration in spring and higher values in autumn (Tables 1 and 3), the values of Ca and Mg in the present study were in close agreement with earlier findings but the values showed a more fluctuating regime.

TDS denote mainly the various kinds of minerals present in water. In natural water, dissolved solids are composed mainly of carbonate, bicarbonates, chloride, sulphates, phosphate, and nitrates of calcium and magnesium, sodium, potassium, iron and manganese etc. In polluted water, the concentrations of other substances increased depending upon the type of pollutants (Al-Saad, 1995). Minimum value was recorded in Um-Al-Warid (546 mg/l; Table 12), while maximum value (3308 mg/l) was observed in Al-Baghdadia1 (Table 2). During different season lower concentration of TDS were observed in autumn at all stations, except Al-Baghdadia 2, while higher concentrations were observed in Hor Al-Hwaiza (Um- AL-Warid and Um-Al- Neiage) with values 1103.33 and 1144.67 mg/l (Tables 9 and 11), respectively. And also in Al-Barga and Al-Nagara (22439.33 and 2265.33 mg/l; Tables 5 and 7), respectively. In Hor Al-Hammar at Al-Baghdadia 1 and 2 during summer season high values of TDS were observed (2840 and 2361.33 mg/l; Tables 1 and 2), respectively. The high values may be due to high current in these stations causing the release of chemical elements and clay particular into the water.

In Hor Al-Hwaiza, lower values of BOD were observed during autumn in Um Al-Neiage and in Um-Al-Warid (2.80 and 2.20 mg/l), respectively, while high values were observed during winter (5.53 and 4.57 mg/l), respectively (Tables 11 and 9). In Hor Al-Hammar at Al-Bagdadiah 1 and 2 lower values of BOD were observed during summer (1.75 and 1.60 mg/l), respectively, while the higher values were observed during spring (14.27 and 13 mg/l), respectively (Tables 1 and 3). In Al-Barga and Al-Nagara, lower

values were observed during autumn (0.97 and 2.8mg/l), respectively, and higher values were observed during winter (6.08 and 6.23 mg/l), respectively (Tables 5 and 7).

Many studies were conducted to estimate the nutrients in the marshlands among which are those of Al-Arajy (1988), Al-Zubaidi (1985), Al-Lammi (1986), Qassim (1986) and Hassen (1988). Most of the previous studies focused upon the relation between the levels of nutrients and the growth of phytoplankton in Al-Hammar marshes. In their study, Al-Saadi *et al*. (1981) determined the levels of nutrients in the central marsh. Al-Hwaiza marshes did not receive any attention due to difficulties in getting into the area and to insecurity (Al-Mausawi and Hussein, 1991).

Clear seasonal variations were reported in many marshes sites, the highest values recorded were during summer which indicates the importance of decomposition of plants and dead organisms due to increase of temperature as well as increase of phosphorous in the water because of decrease consumption by aquatic plants (Al-Aaraji, 1988 and Al-Rekabi, 1992) which enhanced by the lower absorption of phosphorous by phytoplankton than absorption of nitrogen.

Table 1. Mean seasonal variations in the physical–chemical parameters of water from the southern Iraqi marshlands during 2005-2006 in Al-Baghdadia 1.

Season	Winter	Spring	Summer	Autumn
AT ˚C	17.67	24.00	34.27	25.60
WT ˚C	13.60	22.17	27.87	20.73
EC ms/cm	2.12	2.40	3.42	3.26
Sal. ppt	1.41	1.10	1.73	1.60
PH	8.49	7.78	7.43	7.39
TUR.	4.26	4.73	9.38	4.48
D.O. mg/l	6.99	4.33	4.73	6.73
BOD mg/l	3.50	13.00	1.60	1.80
TDS mg/l	1762.67	1379.67	2361.33	1412.33
TSS mg/l	19.00	7.33	27.33	10.67
Ca mg/l	112.22	72.14	138.94	146.98
Mg mg/l	93.96	55.08	129.28	106.92
T.H. mg/l	666.67	413.33	872.00	806.67
HCO3 mg/l	150.49	235.90	248.11	244.03
Cl mg/l	531.75	508.12	718.45	543.57
SO_4 mg/l	413.98	524.17	725.51	807.04

Table 2. Minimum, maximum, range and means with standard deviation of different physical-chemical parameters of Al-Baghdadia 1 during Nov.-2005 to Nov. 2006

Parameters	Minimum	Maximum	Range	Means	Std. Deviation
AT ˚C	12	38.8	26.8	26.54545	9.627395
WT ˚C	12.9	30	17.1	22.21364	6.567651
EC ms/cm	1.93	4.94	3.01	3.177636	1.143068
Sal. ppt	0.8	2.6	1.8	1.69	0.593144
PH	6.8	8.8	2	7.829091	0.650007
TUR.	2.69	11.98	6.02	5.019091	1.627012
D.O. mg/l	2	9.1	7.1	5.009091	2.27704
BOD mg/l	1.2	36	34.8	9.2	12.11785
TDS mg/l	808	3308	2500	2042.545	731.6541
TSS mg/l	3	35	32	16.09091	12.1281
Ca mg/l	48.09	248.5	200.41	133.3553	70.82305
Mg mg/l	19.44	238.14	218.7	112.8855	68.98353
T.H. mg/l	200	1480	1280	791.8182	429.9027
HCO3 mg/l	109.81	317.3	207.49	197.4527	62.18519
Cl mg/l	248.15	1595.25	1347.1	747.6727	349.6652
SO_4 mg/l	230	1278	1048	648.2408	289.2843

Table 3. Mean seasonal variations in the physical–chemical parameters of water from the southern Iraqi marshlands during 2005-2006 in Al-Baghdadia 2.

Season	Winter	Spring	Summer	Autumn
AT ˚C	15.30	24.10	35.27	29.80
WT ˚C	13.88	21.80	27.40	23.70
EC ms/cm	2.25	2.35	3.89	4.39
Sal. ppt	1.50	1.07	1.97	2.27
PH	8.59	7.84	7.56	7.36
TUR.	4.82	4.38	5.96	4.28
D.O. mg/l	7.17	5.00	3.40	5.07
BOD mg/l	13.93	14.27	1.75	2.10
TDS mg/l	2056.00	1230.00	2840.00	1886.33
TSS mg/l	14.00	8.00	31.00	9.00
Ca mg/l	144.29	56.11	130.93	189.71
Mg mg/l	102.06	42.12	150.66	149.85
T.H. mg/l	733.33	340.00	946.67	1090.00
HCO3 mg/l	138.29	199.29	215.57	264.39
Cl mg/l	579.02	484.48	1134.40	815.35
SO_4 mg/l	512.75	439.43	731.83	971.90

Table 4. Minimum, maximum, range and means with standard deviation of different physical-chemical parameters of Al-Baghdadia 2 during Nov. 2005 to Nov. 2006

Parameters	Minimum	Maximum	Range	Means	Std. Deviation
AT ˚C	14.8	36.4	21.6	25.38333	8.337193
WT ˚C	11.9	30	18.1	21.09167	6.661609
EC ms/cm	1.88	4.94	2.15	2.80175	0.698821
Sal. ppt	0.8	2.6	1.3	1.461667	0.34242
PH	6.6	8.76	2.16	7.7725	0.618431
TUR.	2.18	11.98	9.8	5.71	2.791376
D.O. mg/l	1.4	12.4	11	5.6975	2.947307
BOD mg/l	0.2	20.8	20.6	5.281818	7.103072
TDS mg/l	881	3040	2159	1729	543.8436
TSS mg/l	2	34	32	16.08333	10.99966
Ca mg/l	72.14	192.384	120.244	117.5705	47.28618
Mg mg/l	29.16	208.008	178.848	96.30817	53.1155
T.H. mg/l	300	1336	1036	689.6667	312.6157
HCO3 mg/l	97.61	292.84	195.23	219.6308	60.2288
Cl mg/l	283.6	886.25	602.65	575.4717	146.8607
SO_4 mg/l	209.46	1109	899.54	617.6726	266.8417

Table 5. Mean seasonal variations in the physical–chemical parameters of water from the southern Iraqi marshlands during 2005-2006 in Al-Barga.

Season	Winter	Spring	Summer	Autumn
AT ˚C	17.00	24.33	31.47	24.80
WT ˚C	13.90	20.63	29.00	24.10
EC ms/cm	2.53	3.28	3.40	3.51
Sal. ppt	1.53	1.60	1.63	1.77
PH	8.11	7.93	7.50	7.73
TUR.	12.94	14.94	8.26	12.22
D.O. mg/l	9.02	6.87	5.35	6.67
BOD mg/l	6.08	4.63	3.33	0.97
TDS mg/l	1922.00	2439.33	2296.67	1503.67
TSS mg/l	17.67	23.67	16.67	14.67
Ca mg/l	122.90	98.86	141.62	153.65
Mg mg/l	105.30	46.98	113.40	98.02
T.H. mg/l	740.00	440.00	820.00	786.67
HCO3 mg/l	211.50	211.50	207.43	209.46
Cl mg/l	697.18	803.53	850.80	602.65
SO_4 mg/l	531.28	474.43	607.66	835.29

Table 6. Minimum, maximum, range and means with standard deviation of different physico-chemical parameters of Al-Barga during Nov.-2005 to Nov.-2006.

Parameters	Minimum	Maximum	Range	Means	Std. Deviation
AT ˚C	14	33	19	24.4	6.827751
WT ˚C	12.1	32	19.9	21.90833	7.132188
EC ms/cm	2.33	3.97	1.64	3.179167	0.578815
Sal. ppt	1.2	2	0.8	1.633333	0.276614
PH	7.19	8.7	1.51	7.815833	0.450342
TUR.	2.06	25.11	23.05	12.09	7.354459
D.O. mg/l	3.86	10.5	6.64	6.9775	2.192931
BOD mg/l	0.4	13.14	12.74	3.753333	3.715807
TDS mg/l	1310	2758	1448	2040.417	473.0452
TSS mg/l	5	36	31	18.16667	9.475647
Ca mg/l	64.12	184.368	120.248	129.2575	42.90569
Mg mg/l	34.02	165.24	131.22	90.925	43.9677
T.H. mg/l	440	1140	700	696.6667	233.2121
HCO3 mg/l	109.81	280.646	170.836	209.9718	50.27323
Cl mg/l	496.3	1098.95	602.65	738.5417	186.8719
SO_4 mg/l	253	973.3916	720.3916	612.1659	195.6417

Table 7. Mean seasonal variations in the physical–chemical parameters of water from the southern Iraqi marshlands during 2005-2006 in Al-Nagara

Season	Winter	Spring	Summer	Autumn
AT ˚C	16.33	22.83	31.33	23.67
WT ˚C	14.27	21.33	30.03	23.6
EC ms/cm	2.38	3.26	3.29	3.33
Sal. ppt	1.54	1.60	1.63	1.63
PH	8.14	7.85	7.45	7.56
TUR.	9.08	13.41	18.22	19.16
D.O. mg/l	10.03	6.53	7.55	7.40
BOD mg/l	6.23	4.73	5.93	1.60
TDS mg/l	1909.33	2265.33	2518.67	1422.60
TSS mg/l	22.67	24.00	39.33	26.67
Ca mg/l	80.13	101.53	141.61	146.62
Mg mg/l	139.32	55.08	113.40	97.21
T.H. mg/l	773.33	480.00	820.00	773.33
HCO3 mg/l	227.77	207.43	244.04	223.68
Cl mg/l	579.02	756.27	803.53	484.50
SO_4 mg/l	411.34	391.73	620.95	824.12

Table 8. Minimum, maximum, range and means with standard deviation of different physical-chemical parameters of Al-Nagara during Nov. 2005 to Nov. 2006

Parameters	Minimum	Maximum	Range	Means	Std. Deviation
AT ˚C	12	34	22	23.54167	7.309578
WT ˚C	12.3	33	20.7	22.30833	7.664375
EC ms/cm	1.944	3.85	1.906	3.066	0.585911
Sal. ppt	1.2	1.9	0.7	1.600833	0.221625
PH	7.02	8.17	1.15	7.751667	0.385554
TUR.	2.16	26.82	24.66	14.96833	7.800229
D.O. mg/l	4.25	13.5	9.25	7.879167	2.396158
BOD mg/l	0.8	12.6	11.8	4.641667	3.491147
TDS mg/l	1252	2708	1456	2029	485.634
TSS mg/l	8	51	43	28.16667	12.08931
Ca mg/l	48.02	176.352	128.332	118.2253	41.61084
Mg mg/l	48.6	204.12	155.52	101.2533	51.71966
T.H. mg/l	420	1120	700	711.6667	234.7081
HCO3 mg/l	134.22	280.646	146.426	225.7323	37.69766
Cl mg/l	389.95	1028.05	638.1	655.8292	188.4938
SO_4 mg/l	225.5	893.99	668.49	562.0362	232.5374

Table 9. Mean seasonal variations in the physical–chemical parameters of water from the southern Iraqi marshlands during 2005-2006 in Um-Al-Neiage.

Season	Winter	Spring	Summer	Autumn
AT ˚C	18.23	26.00	37.30	26.97
WT ˚C	14.37	23.10	29.73	22.67
EC ms/cm	1.32	1.52	1.11	1.44
Sal. ppt	0.70	0.57	0.37	0.53
PH	7.52	7.72	7.60	7.39
TUR.	5.51	1.76	3.45	7.57
D.O. mg/l	7.69	7.17	8.60	8.87
BOD mg/l	4.57	3.90	2.93	2.80
TDS mg/l	953.00	1144.67	876.33	628.33
TSS mg/l	15.67	6.00	8.67	13.67
Ca mg/l	82.83	76.19	82.83	106.87
Mg mg/l	121.50	46.98	35.64	46.98
T.H. mg/l	706.67	433.33	346.67	450.00
HCO3 mg/l	248.10	296.91	239.97	235.89
Cl mg/l	295.22	330.87	248.15	344.58
SO_4 mg/l	319.04	296.13	231.04	377.29

Table 10. Minimum, maximum, range and means with standard deviation of different physical-chemical parameters of Um-Al-Neiage during Nov. 2005 to Nov. 2006

Parameters	Minimum	Maximum	Range	Means	Std. Deviation
AT ˚C	16.5	40.3	23.8	27.125	7.945625
WT ˚C	12.2	32	19.8	22.46667	6.894546
EC ms/cm	0.96	2.04	1.08	1.346	0.306816
Sal. ppt	0.3	0.9	0.6	0.541667	0.197661
PH	7.14	7.92	0.78	7.556667	0.229796
TUR.	1.27	9.76	8.49	4.571667	3.083666
D.O. mg/l	5.4	13.4	8.1	8.080833	2.238589
BOD mg/l	0.6	7.2	6.6	3.55	2.470002
TDS mg/l	550	1606	1056	900.5833	300.2912
TSS mg/l	3	28	25	11	8.101627
Ca mg/l	48.1	128.256	80.156	87.17883	26.37468
Mg mg/l	24.3	160.38	136.08	62.775	45.43555
T.H. mg/l	200	920	720	484.1667	205.8004
HCO3 mg/l	170.82	366.06	195.24	255.2195	63.18606
Cl mg/l	177.25	431.1	253.85	304.7042	100.3402
SO_4 mg/l	161.0018	464.6	303.5982	305.8756	93.99194

Table 11. Mean seasonal variations in the physical–chemical parameters of water from the southern Iraqi marshlands during 2005-2006 in Um-Al-Warid.

Season	Winter	Spring	Summer	Autumn
AT ˚C	20.03	30.33	36.83	30.33
WT ˚C	14.11	22.40	27.57	23.30
EC ms/cm	1.15	1.43	1.10	1.50
Sal. ppt	0.76	0.50	0.30	0.57
PH	8.15	7.83	7.94	7.37
TUR.	26.60	41.09	43.36	45.05
D.O. mg/l	10.12	10.33	10.73	9.00
BOD mg/l	5.53	6.67	6.67	2.20
TDS mg/l	935.00	1103.33	879.33	648.00
TSS mg/l	13.67	43.67	56.67	40.33
Ca mg/l	128.26	66.79	77.49	101.52
Mg mg/l	92.34	50.22	42.12	56.70
T.H. mg/l	700.00	373.33	366.67	486.67
HCO3 mg/l	207.43	235.90	239.97	227.76
Cl mg/l	283.60	425.40	224.52	348.60
SO_4 mg/l	269.10	323.60	192.27	357.93

Table 12. Minimum, maximum, range and means with standard deviation of different physical-chemical parameters of Um-Al-Warid during Nov.-2005 to Nov.-2006.

Parameters	Minimum	Maximum	Range	Means	Std. Deviation
AT ˚C	17.4	39	21.6	29.38333	8.163871
WT ˚C	12.6	31	18.4	21.845	6.217371
EC ms/cm	0.948	1.93	0.982	1.293417	0.318507
Sal. ppt	0.2	0.8	0.6	0.531667	0.236098
PH	6.85	8.64	1.79	7.82	0.445666
TUR.	4.19	86	81.81	39.025	23.29213
D.O. mg/l	7.2	13.26	6.06	9.946667	1.780793
BOD mg/l	1	10	9	5.066667	3.071669
TDS mg/l	546	1474	928	891.4167	256.0066
TSS mg/l	10	71	61	38.58333	20.73407
Ca mg/l	56.11	200.4	144.29	93.51433	40.74069
Mg mg/l	24.3	155.52	131.22	60.345	34.72023
T.H. mg/l	240	900	660	481.6667	205.9935
HCO3 mg/l	170.82	292.85	122.03	227.7654	32.52887
Cl mg/l	177.25	673.55	496.3	320.5292	131.8784
SO_4 mg/l	102.2	450.8	348.6	285.7252	104.223

The values recorded during 2004 are little bit higher than those recorded in the previous studies (0.008-1.41 µg at P-PO_4/l) (Al-Imarah *et al*., 2006). The seasonal fluctuations of the nutrients (NO_2, NO_3, PO_4 and SiO_2) were determined in 2004. The recorded nitrites were low in the range of 0.001-1.300 µg at N- NO_2/l, while nitrates characterized by high values especially at stations 1 and 2 during winter (1.939 - 42.200µg at N-NO_3/l). Phosphate levels were high at Al-Hwaiza marshes while the Al-Hammar marsh is characterized by high levels of silicate which were in the range of 58.1-146.811µg at Si-SiO_2/l. Al-Imarah *et al.* (2006) concluded that the waters of southern Iraqi marshlands are rich in nutrient especially nitrate and phosphate which enhance the growth and billings of aquatic plants and phytoplankton which are necessary for primary productivity in the food chain.

For comparison, the recorded levels of nutrients in the present study are higher than most previous studies except that of Al-Imarah *et al.* (2006), mostly in Hor Al-Hammar, except those reported for silicate. This is due to high sediment contents of organic matter resulted from decomposition of aquatic plants as rehabilitation and reflooding of the marshlands, the nutrient began to liberate from the sediment to the water column (DouAbul *et al*., 1987). Table (13) shows data of the nutrient concentration in the water of some marshes compared with our result.

Mean seasonal variations in physical-chemical parameters of water from the southern Iraqi marshlands before desiccation are listed in Table (14).

Table 13. Comparison of nutrient values of different marshes of Iraq made previously together with the present results.

Marshes sites	Nitrates (µg at $N\text{-}NO_2^-$ /l)	Nitrates (µg at $N\text{-}NO_2^-$ /l)	Phosphates (µg at $P\text{-}PO_4^{-3}$ /l)	Silicates (µg at $Si\text{-}SiO_2$ /l)	References
Al-Basrah	0.095	1.63	0.68	190.0	Al-Lammi, 1986 and Qassim, 1986
Umm-Al-Hawaly	2.071	3.63	0.78	178.7	
Harer	0.335	9.23	0.89	181.0	
Al-Ghebaysh	0.030	0.055	0.22	11.9	Al-Aaraji, 1988 and Hassen, 1988
Al-Hammar	0.001	0.20	0.09	11.9	
Al-Taar	0.001	0.01	0.01	77.0	
Al-Deer	0.410	3039	1.88	306.0	Al-Zubaidy, 1985
Al-Shafy	0.420	3.91	0.68	325	
Umm-Al-Shwaich	0.130	1.20	1.37	325	
Ahwar	0.680	49.50	3.60	146	Al-Imarah *et al.*, 2006
Um- Al-Warid	0.206	13.41	2.810	38.58	Present study
Um-Al-Neiage	0.177	10.77	2.614	33.92	
B-Al-Baghdadia	0.182	4.84	0.678	49.04	
Al-Baghdadia	0.298	3.67	0.781	27.71	
Al-Nagara	0.660	1.301	0.750	49.92	
Al-Barga	0.086	1.355	0.712	52.02	

Water quality and quantity that enters the marshes via Euphrates at Thee-Qar and Tigris at Maisan were investigated thoroughly during the years 1998–2001, recorded parameters which measure the health and environment of the marshes are listed in Table (15). As shown in the above table, the quality of water entering the marshlands from Tigris and Euphrates rivers are different and mostly better in Tigris than in Euphrates (AOAC, 1984).

Table 14. Mean seasonal variations in the physical–chemical parameters (Temperature in °C, Transparency, T in cm, pH, Total Alkalinity, T. Alk. in mg/l, Dissolved Oxygen, DO in mg/l, Total Hardness, T.H. in mg/Nutrients in µmol/l as Ammonia, NH_4, Nitrite, NO_2, Nitrate, NO_3, Phosphate, PO_4, and Silica, SiO_2) of waters from the southern Iraqi marshlands during the 1970's and 1980's of the last century.

Seasons	T,°C	T	pH	T. Alk.	DO	T.H.	NH_4	NO_2	NO_3	PO_4	SiO_2
Winter	14.92	116.8	8.2	161.0	9.52	889.2	0.35	0.14	0.85	0.20	52.6
Spring	23.27	148.3	7.7	124.0	8.0	836.0	6.18	0.03	0.82	0.21	39.95
Summer	29.78	68.8	7.8	122.7	5.49	972.3	7.55	0.13	2.25	0.54	126.8
Autumn	22.31	56.1	7.9	95.3	7.79	1205.4	9.94	0.23	2.04	0.49	158.1

Table 15. Physical and chemical parameters of water in Thee-Qar and Maisan before entering the marshes, 1998-2001, all units in mg/l unless stated

Years	EC	pH	TDS	Ca	Mg	Na	K	NH_4	PO_4	Cl	SO_4	HCO_3	CO	NO_2	NO_3	B
	Euphrates in The-Qar city															
1998	2.5	8.19	1663	113.7	88.3	288	5.7	0.27	0.05	412	506	147	10	0.13	2.2	0.55
1999	3.1	8.1	2203	143	110	408	8.4	0.4	0.08	562	688	167	9.2	0.13	3.8	0.6
2000	6.01	7.9	4183	202	212	889.8	14.2	0.42	0.09	1295	1203	153	16.4	0.76	0.83	0.65
2001	5.3	7.9	3841	204	180	780	15.03	0.5	0.09	1162	1073	191	4.6	0.09	1.6	0.82
	Tigris in Maisan city															
1998	1.52	8.01	1042	110.5	46.6	141	3.4	0.35	0.08	196	328	151	9.3	0.6	5.1	0.42
1999	2.3	8	1566	137	65	266	4.5	0.34	0.16	373	487	149	8.5	0.15	4.45	0.3

It is evident from the present data that the marshes of southern Iraq with high values of total alkalinity, specific conductivity, dissolved oxygen and alkaline pH along with nutrients and salts being received from inflowing waters and the biodegradation processes within it plus the seasonal variation of some parameters, have provide a suitable habitat for aquatic organism.

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نوعية المياه في اهوار العراق الجنوبية

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المستخلص - بعد إغمار الاهوار بالمياه، تم دراسة نوعية المياه للفترة من تشرين 2005 إلى كانون الأول 2006 لستة مواقع في اهوار العراق الجنوبية، أربعة منها في هور الحمار متمثلة في مناطق البركة والنكارة والبغدادية 1و2 وموقعين آخرين في هور الحويزة هما أم الورد وأم النعاج. تم اختيار هذه المحطات لتغطية توزيع الملوثات فيها ودراسة المتغيرات الكيمائية والفيزيائية المتمثلة في نوعية المياه من قياس كمية الأوكسجين الذائبة المتطلب البيوكيميائي الحياتي والعكارة وكمية المواد الكلية الذائبة والعالقة والتوصيلية والحرارة والدالة الحامضية. كما تمت دراسة المغذيات في هذه المواقع. تراوح معدل القراءات للدالة الحامضية من 7.56 الى 7.84 والتوصيلية الكهربائية 1.29 الى 322 ملي موز على السنتيمتر المربع، الكالسيوم من 87.18 إلى 130.26 ملغم/لتر، والمغنيسيوم من 60.35 الى 111.17 ملغم/لتر، الكلورايد من 304.7 إلى 753.31 ملغم/لتر، المواد العالقة الكلية من 11 إلى 38.58 ملغم/لتر بينما المواد الذائبة الكلية من 891 الى 2040.42 ملغم/لتر وتراوحت كمية الأوكسجين الذائب من 5.16 إلى 10.05 ملغم ملتر أما العكورة فتراوحت بين 4.57 و 39.03 وتراوحت الملوحة بين 0.53 و 1.7 جزء بالألف، أما درجة حرارة المياه فتراوحت بين 21.09 و 22.47 درجة مئوية بينما درجة حرارة الهواء بين 23.54 و 35.26 درجة مئوية. تراوح معدل قراءات الكبريتات بين 285 و 663.89 ملغم /لتر أما البيكربونات فتراوحت بين 204.39 و 255.39 ملغم /لتر والعسرة الكلية بين 481.67 و 777.5 ملغم /لتر. أظهرت الدراسة بان هذه الاهوار غنية ببعض المغذيات وخصوصا النترات والفوسفات التي تساعد في استقرارية النمو والتي تكون مهمة في نمو النباتات المائية والهائمات. كما أوضحت النتائج وجود اختلافات في جميع المتغيرات خلال فترة الدراسة وأيضا ظهر هناك بعض المتقلبات لبعض هذه المتغيرات خلال الفصول المختلفة للمواقع المختلفة لاهوار العراق الجنوبية. بينت نتائج الدراسة بأنها ذات أهمية كونها تعطي معلومات أساسية وتعكس خلفية العمل في أعادة تأهيل اهوار العراق الجنوبية لكونها تعطي أشارة لماهية أعادة التأهيل.