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VEGETATION AND ENVIRONMENTAL FACTORS OF THE SOUTHERN MARSHES OF IRAQ DURING FEBRUARY, 2008

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ABSTRACT

Water, sediments and aquatic macrophytes were collected from 13 fixed stations in February, 2008: two stations at Hor Al-Hammar, two at Hor Al-Chibayish, eight at Hor Al-Huawiza and one near Al-Sindebad Island at the junction of the Tigris and the Euphrates. Physical and chemical properties of water and sediments were studied as well as the concentrations of nutrients, which were variable in the different sites. Biodiversity was also investigated. A number of plant species collected there, was lower than that recorded by other authors due to the time of collection. Cover percent of each species was recorded in addition to biomasses which were also lower than those recorded formerly. Biomass of the emergent plants was the highest among other aquatic plants.

KEY WORDS : Marshes of Iraq, Aquatic plants, Vegetation and environmental factors.

INTRODUCTION

In their lower course the two great rivers the Tigris and the Euphrates create a vast network of wetlands, known as Mesopotamian marshes covering about 15000 sq. km. (Al-Hilli, 1977; Maltby, 1994; Nicholson and Clark, 2002; and Richardson, 2008). in the early 1970s,but the most recent estimates in December 2006 indicate that they reached 58% of their original size (UNEP, 2007).

Three marshlands are recognized, viz., Hor Al-Hammar in the south, Hor Al-Chibayish in the central area and Hor Al- Huawiza in the east. There are other small wetlands distributed, here and there, such as Al-Ghamoga, Al-Sanyia, Al-Saadia and Ibn-Najim marshes. Marshes of southern Iraq are the largest in the Middle East and Western Asia (Al-Hilli *et al*.,2008), Aquatic biodiversity of this ,once, vast wetland complex was converted to parched desert in the period between 1992 and 2003 due to discussion. After that time the area was refolded and most species are re-established.

The majority of aquatic plants especially submerged and floating taxa are affected by the physical and chemical properties of water as well as the concentration of nutrients. Emergent plants are affected by these characters in the sediments as well.

Previous studies of the area were focused on Al-Hammar marshland in particular. Little studies were concerns with Chibayish marshes, but there is no attention or publication about Huawiza marshes because of its neighborhood to the Iraqi-Iranian borders, the site that was dangerous and very difficult to be visited by researchers due to the continuous political problems between the two countries.

The present study aims at studying the environmental conditions of the three marshes and their influence on the biodiversity of this area during February 2008.

MATERIALS AND METHODS

Plants, water and sediments were collected in 5-19th of February 2008 from 13 stations Fig.1, two at Hor Al-Hammar (Al-Barga and Al- Kermashiya), two at Hor Al-Chibayish (Abu-Zerig and Al-Baghdadiyah) and eight at Hor Al-Huawiza (Al-Baidha, Al-Odhaim, Al-Soda North, Al-Soda South, Lisan Ojairdah, Majnoon, Umm Al-Niaaj and Umm Al-

Warid).

The remaining station was at Al-Sindebad Island near the junction of rivers Tigris and Euphrates.

Physical, chemical properties and nutrient content of water and sediments were investigated as well as vegetation species composition.

Air and water temperature was measured using simple thermometer (graduated 0-100 °C) ,water pH and EC were measured *in situ* using portable pH meter model Hanna HI-9821.

Turbidity was measured by turbidity-meter model Hanna LP-2000.

Dissolved oxygen was analyzed with Winkler method (APHA, 1995).

Triplicate samples of sediment were collected from each station with a Grab sampler. Samples were kept in plastic bags, then cleaned from root remains and contaminants, dried, grinded in a mortar and stored in a labeled polyethylene containers then analyzed.

Soil separates were determined in the sediments of 12 stations as mentioned in Black (1965).

pH was measured by a pH-meter model Lutren-pH-206. EC was measured using EC meter model Ogawa-Seiki-CM-1K.

Total nitrogen and available potassium were recorded following Page *et. al.,* (1982). Available phosphorus was determined as in Murphy and Riley (1962) using spectrophotometer at wave length 700nm, while organic matter was recorded as in Wakely and Black (1934).

Aquatic plants were collected from all stations using quadrate method. Twenty replicates were carried out for presence and cover percent and ten replicates for biomass were taken in each site. Floristic lists were also made at each station.

RESULTS AND DISCUSSION

Physical and chemical properties of water

Water quality is affected by several ecological factors whether climatic, geologic or floristic (Wetzel, 2001).

Temperature is one of the most important factors that many affect alkalinity, salinity, dissolved oxygen, etc.

The highest air temperature (25 °C) was recorded at Al-Soda south while the highest water temperature (16.67 °C) was in Majnoon station. The lowest air and water temperatures were recorded at Al-Sindebad station Table 1.

pH values varied between (7.29 – 8.76). Variations between stations were not significant but values lie at the basic side. Generally, all Iraqi waters are classified as weak alkaline waters. Similar observations were made by other authors such as Richardson and Hussain (2006), and Mahmood (2008).

Electrical conductivity (EC) is a significant index of salinity. The highest value of 8.19 dc.m^{-1} was at Al-Barga station because it is affected by the saline area surrounding it and the high tide of the gulf.

Water turbidity was significantly highest at Al-Sindebad station due to the discharge of Tigris and Euphrates carrying sediment and detritus particles through water turbulence of the basin, while the lowest value was at Abu-Zerig. This result is not

Table 1. Physical and chemical features of water in the southern marshlands

No.	Parameters / Stations	AT° C	WT °C	Water depth (cm)	pH	Turbidity	EC dc.m^{-1}	Salinity ‰	D. O. Mg.l^{-1}	Nutrients µg.l^{-1} * NO_3	NO_2	PO_4
1	Al-Sindebad	10.1	9.90	65	8.56	42.04	3.19	1.53	9.30	21.68	0.19	2.62
2	Al-Barga	13.7	10.13	45	8.65	12.03	8.19	4.43	7.20	15.36	0.19	2.44
3	Al-Kermashiya	14.0	12.23	155	7.81	1.51	4.50	2.40	6.95	20.78	0.09	3.00
4	Abu-Zerig	18.0	12.80	182	8.56	9.00	1.25	0.40	8.60	19.83	0.27	2.94
5	Al-Baghdadiya	11.8	10.60	115	8.1	2.40	4.19	2.10	8.07	20.23	0.08	2.81
6	Al-Baidha	17.0	12.60	184	7.93	1.90	1.97	0.80	10.00	14.46	0.11	1.75
7	Al-Odhaim	18.0	14.10	199	8.48	1.93	1.89	0.80	12.30	15.66	0.07	5.81
8	Al-Soda North	20.0	14.70	253	8.46	0.92	1.76	0.70	12.40	14.86	0.08	2.50
9	Al-Soda South	25.0	12.50	237	7.29	0.85	1.95	0.80	-	13.14	1.24	4.44
10	Lisan Ojairdah	17.0	14.43	158	8.44	1.18	2.40	1.10	9.00	15.48	0.10	2.44
11	Majnoon	20.0	16.67	130	8.76	1.34	1.96	0.80	7.10	15.74	0.08	2.48
12	Umm Al-Niaaj	16.0	14.00	-	8.44	3.56	1.61	0.60	11.50	14.62	0.09	5.56
13	Umm Al-Warid	19.0	15.00	-	8.08	6.10	1.68	0.70	10.00	15.06	0.08	3.37

*Nutrient data were provided by Marine Science Centre.

uncommon: stagnant or slow moving waters are clearer than running waters.

Dissolved oxygen play an essential role in the metabolic processes of all organisms. Source of dissolved oxygen is atmosphere as well as phytoplankton and aquatic macrophytes which provide water bodies with oxygen by photosynthesis (Wetzel and Linkens, 2000).

Oxygen concentration in water bodies is a function of biological process (Al-Saad *et al.*, 2010)

Dissolved oxygen concentration was high in general although it was lower than those recorded by Mahmood (2008) in the same area during 2006. The highest concentration (12.4 mg/l) was recorded at Al-Soda North while the lowest (6.95 mg/l) was at Al-Kermashiya. The high concentration may be due to the dense presence of aquatic macrophytes and phytoplankton.

Dissolved oxygen concentration is related with low temporal as well as water depth as shown in Table 1, that habitats with deepest water were dominated by submerged and floating plants which provide water with oxygen (Al-Hilli *et al.*, 2008).

Nutrients concentrations are high Table 1. Al-Saad *et al.* (2010) mentioned that waters of the southern Iraqi marshes are rich in nutrients especially nitrate and phosphate which enhance their stability for growth and billing of aquatic plants and phytoplankton.

Goldstein (1981) found water quality degradation (nutrient loading) to be correlated positively with the degree of agriculture development in the water shed.

Sediments

Table 2 shows that soil texture is ranged between clay and clay mixture where sediments of half sites were clayey. Sindebad site shows the lowest content of sand (115.8 $g.kg^{-1}$). Thus heavy material (sand) settled down along its way downstream in Shatt Al-Arab.

Mahmood (2008) found that sand content in sites of Siba and Ras Al-Bisha in Shatt Al-Arab was the lowest among eight stations distributed between marshes and Shatt Al-Arab where clay content of the substratum reached its highest value (557.9 $g.kg^{-1}$).

pH of sediments lies on the alkaline side was due to the gypsum nature of the bottom and soil of marshes, ranging between 7.59 at Umm Al-Niaaj and 8.07 at Abu-Zerig. Variation was mainly due to station position and may be attributed to biological and chemical activities in each site (Rezk and Al-Edany, 1980). This factor is very important that it interferes with availability of nutrient ions. Low acidic values may prevent ion absorption.

Electrical conductivity was ranged between 1.60 dc/m at Abu-Zerig and 8.20 dc/m at Umm Al-Niaaj.

Total Nitrogen (TN)

Values of total nitrogen in the studied sites ranged between 1.12 $g.kg^{-1}$ at Abu-Zerig and 7.28 $g.kg^{-1}$ at Al-Odhaim. Quality of the surrounding areas affects the rate and time of nutrients entrance (Butzler, 2002).

Values were low in general except for the sites of Al-Odhaim and Umm Al-Niaaj at Hor Al-Huawiza. Higher nitrogen content in Huawiza marshes may

Table 2. Separates and Soil texture of sediments in sites of study area

No.	Parameters / Stations	Soil separates			Soil texture
		Sand	Silt $g.kg^{-1}$	Clay	
1	Al-Sindebad	115.8	326.3	557.9	Clay
2	Al-Barga	200.0	319.0	481.0	Clay
3	Al-Kermashiya	210.0	369.0	421.0	Clay
4	Abu-Zerig	372.5	240.0	386.4	Clay mix.
5	Al-Baghdadiya	369.0	288.9	342.1	Clay mix.
6	Al-Baidha	328.2	271.8	400.0	Clay mix.
7	Al-Odhaim	370.0	243.0	387.0	Clay mix.
8	Al-Soda North	-	-	-	-
9	Al-Soda South	260.0	323.0	417.0	Clay
10	Lisan Ojairdah	218.0	310.0	409.0	Clay
11	Majnoon	269.0	340.0	391.0	Clay mix.
12	Umm Al-Niaaj	300.3	305.0	394.7	Clay mix.
13	Umm Al-Warid	152.6	363.2	484.2	Clay

be due to increase in plant remains and detritus and animal wastes settled there (Mahmood, 2008).

Available Phosphorus

Phosphorus is one of the most important elements in the natural ecosystems. Agricultural activities are responsible for eutrophication of water and sediments due to high phosphorus content (Sharpley, 2000) which may act to change the ecological factors. Values of phosphorus showed the lowest content (10 $mg.kg^{-1}$) at Lisan Ojairdah (as well as total nitrogen) where there are no agricultural activities at all. While the highest value (32 $mg.kg^{-1}$) was recorded at Umm Al-Warid station in Hor Al-Huawaiza because of its proximity to dense population and agricultural activities, where water movement is low, permitting sediment particles to absorb larger quantity of phosphorus (Mahmood 2008), as well as the clayey texture of sediments that give them opportunity to absorb large quantities of phosphorus.

Available Potassium

Potassium is another essential element in the sediments. Its concentration may reflex the drainage of agricultural wastes. Its concentration ranges between 2200 $mg.kg^{-1}$ at Majnoon and 7540 $mg.kg^{-1}$ at Al-Kermashiya.

The highly organic and clayey nature of the soil may be responsible for the accumulation of potassium ion in seasons when its concentration in the overlying water has already dropped (Rezk and Al-Edany, 1980).

Buttery *et al.* (1965) reported that minerals in mud rather than water are the main source of nutrients for the aquatic plants and that anaerobic conditions in the mud are not as deleterious to its root growth as to associated *Glyceria*.

Organic matter

Table 3 shows that organic matter in the substratum ranges between 12.2 $g.kg^{-1}$ at Umm Al-Warid and 71.7 $g.\ kg^{-1}$ at Al-Odhaim. This material may be derived from either plant, animal, bacteria or phytoplankton detritus or all. Animal wastes which are thrown directly to the surface water may increase the organic matter in water and sediments (Mahmood, 2008).

Vegetation

Biodiversity and distribution

Table 4 shows a list of 23 species collected in February 2008. Many species disappear due to climatic and edaphic conditions in this season.

The highest plant diversity was at Al-Baghdadiya station in Hor Al-Chibayish. This may be caused by the lower water salinity, high concentration of nutrients or variation in water depth in different locations that preferring different microhabitats in this site Table 1.

The most common species in different sites are *Phragmites australis* and *Ceratophyllum demersum*. *P. australis* can tolerate a wide range of inundation and salinity levels (Van der Toorn, 1972). Al-Hilli *et al.* (2008) stated that tall emergent forms are characteristic of permanent and sub-permanent wetland communities. *P. australis* community was wide spread as monospecific stands throughout the study area.

Table 3. Physical and chemical characteristics of sediments in the southern marshlands

No.	Parameters Stations	pH	dc/m EC	Total Nitrogen $g.kg^{-1}$	Available Phosphorus $\mu g.g^{-1}$	Available Potassium $mg.kg^{-1}$	Organic matter $g.kg^{-1}$
1	Al-Sindebad	7.95	2.40	1.26	25	2740	28.4
2	Al-Barga	7.87	5.80	1.54	26	5300	14.9
3	Al-Kermashiya	7.80	6.06	3.78	20	7540	24.4
4	Abu-Zerig	8.07	1.60	1.12	24	2500	20.3
5	Al-Baghdadiya	7.85	3.80	2.17	18	3425	16.2
6	Al-Baidha	7.96	5.60	0.50	22	5300	20.7
7	Al-Odhaim	7.74	6.40	7.28	23	3300	71.7
8	Al-Soda North	-	-	-	-	-	-
9	Al-Soda South	7.82	6.00	3.50	27	3520	39.3
10	Lisan Ojairdah	8.04	2.00	1.19	10	3520	28.4
11	Majnoon	7.90	2.10	1.89	24	2200	13.5
12	Umm Al-Niaaj	7.59	8.20	6.16	30	3520	62.3
13	Umm Al-Warid	7.78	2.60	1.54	32	2600	12.2

Table 4. Species presence in different stations and their habitat.

Stations / Species	Al-Sindebad	Al-Barga	Al-Kermashiya	Abu-Zerig	Al-Baghdadiya	Al-Baidha	Al-Odhaim	Al-Soda North	Al-Soda South	Lisan Ojairdah	Majnoon	Umm Al-Niaaj	Umm Al-Warid	Habitat
Bacopa monniera (L.)Wett.	+													S
Ceratophyllum demersum(L.)	+	+	*	*	+	+	+	*	+	*		+	*	S
Chara sp.							+			*				S
Cladium mariscus (L.)Pohl								+						E
Cyperus molaccensis Lam.		+												E
Hydrilla verticillata (L.f.)Royle	+										+	*	+	S
Juncus acutus L.	+	*												E
Lemna gibba L.												*	*	F
Myriophyllum spicatum L.					+	*	+			+	+	+		S
Najus marina L.			+		+		+				*			S
Najus minor All.						*				+				S
Nitella sp.							*							S
Panicum repens L.	+													A
Phragmites australis (Cav.)Trin ex Steud.	+	+	+	+	+	+	+	+	+	+	+	+	+	E
Polygonum amphibium L.	+													A
Potamogeton crispus L.	+	*									+		*	S
Potamogeton lucens L.					+									S
Potamogeton pectinatus L.		*			*									S
Potamogeton perfoliatus L.						+								S
Salvinia natans (L.)All.				*	*								*	F
Schenoplectus litoralis (Schrad.)Palla	+			+	+	+								E
Typha domingensis Pers.	+	+	+	+	+	+				+				E
Vallisneria spiralis L.	+													S

A: Amphibian ; E: Emergent ; F: Floating : S: Submerged. +: present ; * : occasional.

The most conspicuous phenomenon is the massive presence of *Hydrilla verticillata* in semi-isolated marshes such as Majnoon site. This invasive plant was first recorded by Alwan (2006) in Abu-Zerig and central marshes (Hor Al-Chibayish), but now it spreads in all marshes reaching Shatt Al-Arab downstream approaching Abu Al-Khasib site.

This plant can spread very quickly showing significant tolerance to low light levels (less than 1% of the total sunlight) and can grow at depths up to 10-14 m below water level (Holm *et al.*, 1997), resulting in a longer growing season than other submerged species and being capable of out competing other submerged plants (Alwan 2006).

Ceratophyllum communities are more common. They thrive almost at all studied sites.

There are also dead stems and remains of the salt cedar (*Tamarix* spp.) which was very common in all marshes before inundation. The present list of aquatic plants is far from complete mainly because collection time was rather limited. So they are much less than listed by Alwan (2006).

Covering percent

Table 5 shows that the submerged plant *Ceratophyllum demersum* has the highest cover percent. Hussain and Alwan (2008) recorded the same feature, and concluded that this plant is common in Iraqi rivers and marshes because of its tolerance to wide salinity range, a reason why it is found in the farthest reach of the Shatt Al-Arab river.

The common reed *Phragmites australis* is one of the most widely distributed plants on earth (Graneli, 1984). This emergent littoral plant has also a considerable cover percent but a lesser extent than *Ceratophyllum*. Much of this is in the form of small stands and narrow littoral bonds, although monospecific reed areas of several hundred donums are also found.

Although *Myriophyllum* is known by its cover percent in all marshes. It has no considerable present in this study that the plant shows its intensive presence and distribution during other seasons. This is

Table 5. Covering percentage of species under study in different stations

Stations / Species	Al-Sindebad	Al-Barga	Al-Kermashiya	Abu-Zerig	Al-Bagdhadiya	Al-Baidha	Al-Odhaim	Al-Soda North	Al-Soda South	Lisan Ojairdah	Majnoon	Umm Al-Niaaj	Umm Al-Warid
Ceratophyllum demersum	35.71	100	*	*	35.7		62	*	100	*		37.9	*
Chara sp.							25			*			
Cyperus molaccensis		50											
Hydrilla verticillata	20										* - 50	*	100
Juncus acutus	30	*											
Lemna gibba												*	*
Myriophyllum spicatum					20	*				* - 10	45		
Najus marina			63		41.3		6.4			* - 67.7	*	5	
Najus minor						*				*			
Nitella sp.							*						
Panicum repens	10												
Phragmites australis	35	25	10	18	27.5	13.3	26.9	25	27.8	22.5	30.8	20.6	15.6
Polygonum amphibium													
Potamogeton crispus	40	*									* - 30		*
Potamogeton lucens					60								
Potamogeton pectinotus		*			*					30			
Potamogeton perfoliatus						* - 100							
Salvinia natans	*		*		*							*	*
Schenoplectus litoralis	30			50	45	5							
Typha domingensis	31.3	30	30		30	13.3				20			
Vallisneria spiralis	25												

Table 6. Biomass of some plants under study (g/m²)

StationsSpecies	Al-Sindebad	Al-Barga	Al-Kermashiya	Abu-Zerig	Al-Baghdadiya	Al-Baidha	Al-Odhaim	Al-Soda North	Al-Soda South	Lisan Ojairdah	Majnoon	Umm Al-Niaaj	Umm Al-Warid
Ceratophyllum demersum	40	665			30		143.8		180			62	
Cyperus malaccensis		295											
Hydrilla verticillata	155										20		137.33
Juncus acutus	100												
Myriophyllum spicatum					72.5					20	71	120	
Najus marina			90		133.3		30			186.7			
Nitella sp.							65						
Phragmites australis	332.86	347.5	298.3	150	436.8	290.7	411.9	429	266.1	172.5	284.2	285	166.5
Potamogeton lucens					180								
Potamogeton pectinotus											10		
Potamogeton perfoliatus										10			
Schenoplectus litoralis	85		625		265	167.5							
Typha domingensis	335	709.6	402.1	277.5	387.5	353.3				122.5			
Vallisneria spiralis	5												

also true for many other aquatic plants.

Biomass

As shown in Table 6, emergent plants (*Phragmites australis* and *Typha domengensis*) and submerged plant (*Ceratophyllum demersum*) have the highest biomass among other aquatic plants.

The clearly less biomass recorded in this study for emerged plants in comparison with previous studies (Al-Hilli *et al.,* 2008; Husain and Alwan, 2008) is due to the time of collection where only sprouts of the new growing season were cut down neglecting dead culms of the last growing season.

The previous studies stated that the biomass of the common reed and other emerged plants is the highest among other aquatic macrophytes.

Graneli (1984) found a biomass of 1 kg.m^{-2} in Sweden and 1-3 kg.m^{-2} in some European countries while Al-Hilli *et al*. (2008) stated that emergent communities in eutrophic waters produce more than intensified field cultures, being 1-2 kg. m^{-}-^{2} net per annum in temperate zone and 4-8 kg. m^{-2} in tropical and subtropical zones.

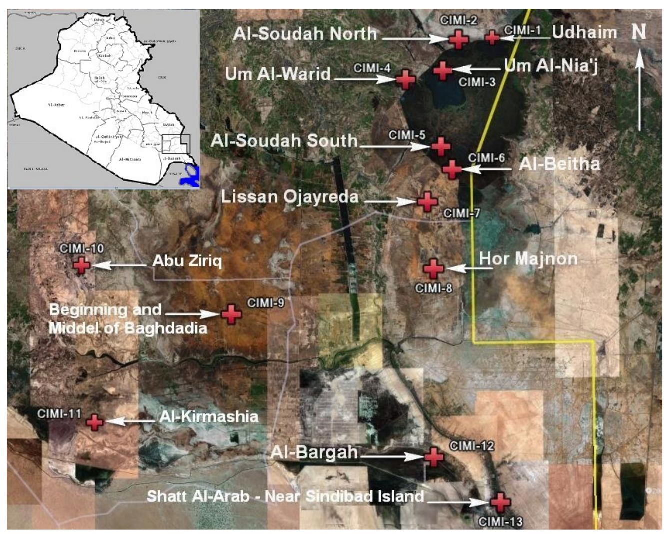

Fig. 1. Map showing the study area and sampling stations. Provided by the Marine Science Center.

Hussain and Alwan (2008) recorded the highest values of biomass for *Phragmites australis* and cover percent for submerged macrophytes especially *Ceratophyllum demersum* followed by emerged macrophytes.

REFERENCES

Al-Hilli, M. R., Warner, B. G., Asda, T. and Doubual, A. 2008. An assessment of vegetation and environmental controls in the 1970 s of the Mesopotamain wetlands of souther Iraq. *Wetlands Ecol. Manag.* (doi:10,1007/s 11273-008-9099-1)

Al-Hilli, M.R. 1977. *Studies on the plant Ecology of Ahwar region in Southern Iraq.* PhD Thesis, University of Cairo, Cairo, Egypt.

Al-Saad, H.T., Al-Hello, M. A., Kareem, S. M. and Douabul, A. 2010. Water quality of the southern marshes of Iraq during winter 2008. *Mesopot. J. Mar. Sci.* 25 (2): 188-204.

Alwan, A. A. 2006. Past and present status of the aquatic plant of the marshland of Iraq. *Marsh Bulletin.* 1(2): 160-172.

APHA (American Public Health Association) 1995. *Standard Methods for Examination of Water and Wastewater.* Washington, DC 20036,1193pp.

Black, C. A. 1965. *Methods of Soil Analysis,* Part 1. Physical properties. Wisconsin, Madison Amer. Aron. Inc. Publisher.

Buttery, B. R., Williams, W. T. and Lambert, J. M. 1965. Competition between *Glyceria maxima* and *Phragmites communis* in the region of Surilingham Broad.II : The fen gradient. *J. Ecol.* 53 : 183-196.

Butzler, J. M. 2002. The role of nutrient variability in aquatic ecosystems. B.S. University of Pittsburgh. 50pp.

Goldstein, A. L. 1981. Upland deter nation / retention demonstration project. Third annual report to the Coordination Council on the Restoration of the Kissimmee River Valley and Taylor Creek/Nubbin Slough Basin. 185pp.

Holm, L., Dool, J., Holm, E., Pancho, J. and Herberger, J. 1997. *World Weed Natural Histories and Distribution.* 48: *Hydrilla verticillata* (L.f.) Royle. pp 393-411. John Wiley & Sons inc., New York.

Hussain, D. A. and Alwan, A. A. 2008. Evaluation of aquatic macrophytes vegetation after restoration in east Hammar marsh, Iraq. *Marsh Bulletin.* 3(1) : 32-44.

Lagan, G. and Longmore, A. 2005. Sediment, organic matter and nutrient. OZ estuaries information about Australian estuaries and coasts.

Mahmood, A. A. 2008. *Concentrations of pollutants in some wetlands in south of Iraq.* Ph.D. Thesis, Basrah university.

Maltby, 1994. An environmental and ecological study of the marshlands of Mesopotamia. Draft Consultative Bulletin. Wetland Ecosystem Research Group. University of Exeter. Published by AMAR Appeal Trust, London, 225 pp.

Murphy, T. and Rilely, J. R. 1962. A modified single solution method for determination of phosphate in natural water. *Anal. Chem. Acta.* 27 : 31-36.

Nicholson, E. and Clark, P. 2002. The Iraqi Marshlands : A Human and Environment study. The Amar Appeal International Charitable Foundation.

Page, A. L., Miller, R. H. and Keeney, D. R. 1982. *Methods of Soil Analysis,* Part (2) 2nd ed. Agronomy 4. Wisconsin, Madison. Amer. Soc. Agron. Inc. Publisher.

Rezk, M. R. and Al-Edany, T. Y. 1980. Ecology of Phragmites austeralis (Cov.) Trin ex Steud. In Shatt Al-Arab, IRAQ. Part 1. seasonal and regional variations in the chemical constituents of water and soil in reed bebs. *Pol. Arch. Hydrobiol.* 27(3) : 349-358.

Richardson, C. J. and Hussain, N. A. 2006. Restoring the garden of Eden: An ecological assessment of the marsh of Iraq. *Bioscience.* 56 (6) : 477-489.

Richardson, C.J. 2008. Wetland of mass destruction: Can the "Garden of Eden " be fully restored?. Published by the Environmental Law Institute. 30 (3) : 1-33.

Sharpley, A. 2000. Managing phosphorus agriculture and environment. College of science ,the Pennsylvania state University, 8 pp.

UNEP, 2007. UNEP Project to help, manage and restore the Iraqi Marshlands.Geneva:UNEP. Available at http:// marshlands.unep.or./p/.

Van der Toorn, J. 1972. Variability of Phragmites australis (Cav.) Trin ex Steud. in relation to environment. Van Zee Ld. 48-122.

Wakley, A. and Black, I. A. 1934. An examination of a rapid methods for determinating organic carbon in soils. Effect of variation in digestion condition and of inorganic soil constituents. *Soil Sci.* 63 : 251-263.

Wetzel, R. G. 2001. Limnology, lake and river ecosystems 3rd ed. Academic press, an Elsevier Science imprint, San Francisco, New York, London, 1006pp.

Wetzel, R. G. and Linkens, G. E. 2000. *Limnlogical Analysis.* 3rd ed. Springer-Verlag, New York, Berlin, Heidelberg Springer 429 pp.