

Designated Protected Marsh within Mesopotamia: Water Quality

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Abstract This survey was carried out during wet and dry seasons in three stations represent the upper, middle and lower reaches of Huweza Marsh, Southern Iraq. Physical and chemical parameters including the natural water quality parameters such as temperature, pH, salinity, turbidity, electrical conductivity, dissolved oxygen, bicarbonates and total hardness along with nutrients levels were monitored for the period from July 2007 to April 2008. Results showed that water quality parameters of Huweza marsh are all within the standard criteria for freshwater habitats with pronounced seasonal variation between dry and wet seasons. Significant differences were also recorded between upper and lower stations in the marsh which can be attributed to local conditions. In general all parameters are within the tolerance limits of fresh water plants and animals except water salinity which needs to be monitored seasonally and spatially, as variations are noticed between various parts of the marsh and at different seasons. Some recorded levels exceed the normal favorable levels for freshwater fauna and flora. The marsh water is rich in nutrient especially nitrate and phosphate, reflecting high productivity in similar manner to other Iraqi marshes. Results were compared with other studies in the area. The present survey can act as a basis for future monitoring and recovery of the marshland ecosystem.

Keywords: mesopotamian marshlands, water quality, nutrients, protected area

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1. Introduction

Marshes in the middle and lower basin of the Tigris and Euphrates Rivers in Iraq were 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 the Mesopotamian Marshes. These wetlands comprise a complex of inter-connected shallow freshwater lakes, marshes and seasonally swamped floodplains extending from the region of Basrah to within 150 km of Baghdad [1]. Iraqi southern marshes form a large triangular region bounded by three major southern cities: Nasiriyah to the west, Amarah to the northeast, and Basrah to the south. Their vast area covers 20,000 square kilometers of open water, and includes both permanent and seasonal marshes. Much the largest wetlands within this complex are: 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; Huweza and its associated marshes (220,000 ha) extending east from the Tigris into neighboring Iran. Such specific wetlands of the southern part of Iraq play a vital role in the maintenance of biodiversity in the Middle East [2] primarily because of

their large size, the richness of their aquatic vegetation [3] and their isolation from other comparable systems. The values of the Marshes are numerous, including rich flora and fauna, livestock grazing fields, fish and other wildlife breeding places [4]. Marshes are also known to be a farmland for rice, and cultivation areas for some other crops. Species lists, classifications, specific characteristics, water chemistry and some physical factors of the area can be sought in number of studies [1].

Huweza Marsh in Iraq covers an area eastern Tigris, extending from Alsheeb in Alimarah (Misan) province in the north, to Alswuaib in Basrah province in the south. The total area of the Marsh (Al Azim and Al Huweza marshes) used to vary between 2,000-3,000 km² according to the hydrological condition. According to Al-Qurna Water Resources Office, the total area of the marsh is 2350 km² reaching 2500 km² during wet season with an average length of 80 km and 30 km in width. The Marsh in its south-western parts (in Iraq) is in closer vicinity to the Tigris River and has an outlet into the Euphrates. It seems that the Tigris had been recharging the Marsh from its upper and middle parts. However, both the Tigris and Euphrates drain it at its lower part in the south. After April 2003, more water has been released which covered nearly 83% of the marsh during 2006-2007 with total refolded area of 1950 km² out of the 2350 km² which represents the previous area of the marsh.

Huweza Marsh is the only natural remaining marsh on the Iranian border. Since 2003 until 2005 monitoring was done for water quality, water depth and transparency, soil chemistry and ecological indicators of plant and algal productivity, bird and fish. The monitoring was done by Iraqi research teams supported by the US Agency for International Development and by New Eden project, supported by Italian government funds. Water quality for Huweza Marsh was as follows: (salinity 0.87 ppt; electrical conductivity (EC) about 1.74mS/cm; pH 7.6; dissolved oxygen (DO) 7.7 mg/l; total nitrogen (TN) 464 mg/l, total phosphorus (TP) 133 mg/l). Salinity of the natural Huweza Marsh very low when compared with restored marshes. Two other surveys had been conducted in Huweza Marsh. The first one is the KBA survey which was conducted from June 2004 to March 2006 in three monitoring points in Huweza marsh. The following parameters were measured: water column depth(WCD), water current and light penetration (LP), physic- chemical features such as water temperature (WT), pH, salinity, DO and suspended particulate matter (SPM). Nutrients like phosphate (PO_4), nitrite (NO_2), nitrate (NO_3), silicate (SiO_4) and chlorophyll-a were also monitored. The second main survey was conducted by United Nations Environmental Program (UNEP) from April 2005 to December 2005. In addition to the basic physico-chemical parameters and nutrients levels, the survey measured the levels of several heavy metals such as antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc.

The purpose of this study is to evaluate water quality and nutrients levels of Huweza marsh in accordance to the continuous alteration of its ecosystem and to detect sub-marsh that can be designated as protected area. The other aim is establishing a long term monitoring and assessment of the marsh health.

2. Material and Methods

Water samples were collected for the period from July 2007 to April 2008 from three different stations in Huweza Marsh as shown in Figure 1 and Figure 2.

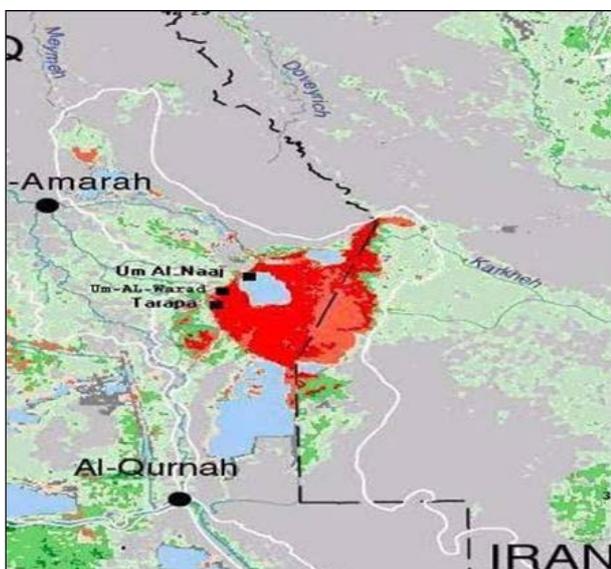


Figure 1. Map of Huweza Marsh showing the sampling sites



Figure 2. Photographs of two of Huweza Marsh Stations

1. Um Al-Niaj: It represents the Northern part of the marsh which extends to 10 km in length and 7 km in width. (Latitude 31 36 0.0, Longitude 47 35 0.0).
2. Lisan Ajerda: It represents the median part of the marsh which contains a middle dike separating the northern and southern parts of Huweza (Latitude 31 17 27.0, Longitude 47 34 37.3).
3. Al-Suwaib (Al-Safya): It represents the southern part which is connected with Al-Suwaib river and then with Shatt Al-Arab river at 3 km before the point where Tigris and Euphrates meet (Latitude 31 7 58.7, Longitude 47 35 32.8).

Parameters like air temperature (AT) and WT was measured by simple thermometers with range from (10-100°C) graduate at 0.2°C, pH was measured using pH meters model HANNA HI-9821. EC was measured using portable digital conductivity meters (WTW 3301). Alkalinity (HCO_3) were analyzed according to the standard method given in [5], while the rest of parameters such as DO, and total hardness (TH), analyzed according to [6]. Nutrients (NO_3 , NO_2 , PO_4 , SiO_4) were measured by [7].

3. Results and Discussion

Monthly variation of water quality parameters of the three selected marshes are listed in Table 1 and showed in Figure 3.

Table 1. Water quality measurements in the selected marshes of Huweza during the study period

		WT	Sal.	EC	pH	DO	Tur.	HCO ₃	T-H	NO ₃	NO ₂	PO ₄	SiO ₂
		°C	mg/L	mS/cm		mg/l	FTU	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L
Jul-07	Um Al-Niaaj	27	0.3	1.1	7.3	8	12	268	340	7.5	0.0	0.8	45
	Lissan Ijerda	29	0.9	2.0	7.8	7	9	256	320	0.4	0.1	1.7	4
	Al-Safya	29	0.9	2.1	8.4	8	8	244	320	4.5	1.1	1.3	15
Aug-07	Um Al-Niaaj	29	0.3	1.1	7.9	7	6	256	380	7.5	0.1	0.9	46
	Lissan Ijerda	29	0.8	2.0	7.9	6	7	268	360	0.5	0.2	2.6	6
	Al-Safya	29	0.9	2.1	8.6	8	6	310	300	2.4	0.9	2.4	17
Sep-07	Um Al-Niaaj	28	0.3	1.1	7.5	8	10	256	340	8.4	0.1	0.8	45
	Lissan Ijerda	30	0.8	2.0	7.9	5	6	293	300	0.2	0.2	3.4	6
	Al-Safya	29	0.9	2.0	8.5	8	5	275	300	3.6	0.5	0.9	40
Feb-08	Um Al-Niaaj	12	0.6	1.6	8.0	8	4	549	650	15.0	1.1	3.3	70
	Lissan Ijerda	11	0.9	2.2	8.8	9	1	488	840	12.4	0.6	2.1	10
	Al-Safya	19	1.5	3.0	9.0	12	5	610	860	20.0	0.1	3.0	47
Mar-08	Um Al-Niaaj	18	0.8	2.0	8.2	8	4	671	600	14.2	1.7	2.6	32
	Lissan Ijerda	16	0.8	1.8	7.9	9	2	610	600	6.9	1.0	0.6	6
	Al-Safya	-	-	-	-	-	-	-	-	-	-	-	-
Apr-08	Um Al-Niaaj	18	0.8	2.0	8.2	8	4	671	600	14.2	1.7	2.6	32
	Lissan Ijerda	16	0.8	1.8	7.9	9	2	610	600	6.9	1.0	0.6	6
	Al-Safya	-	-	-	-	-	-	-	-	-	-	-	-

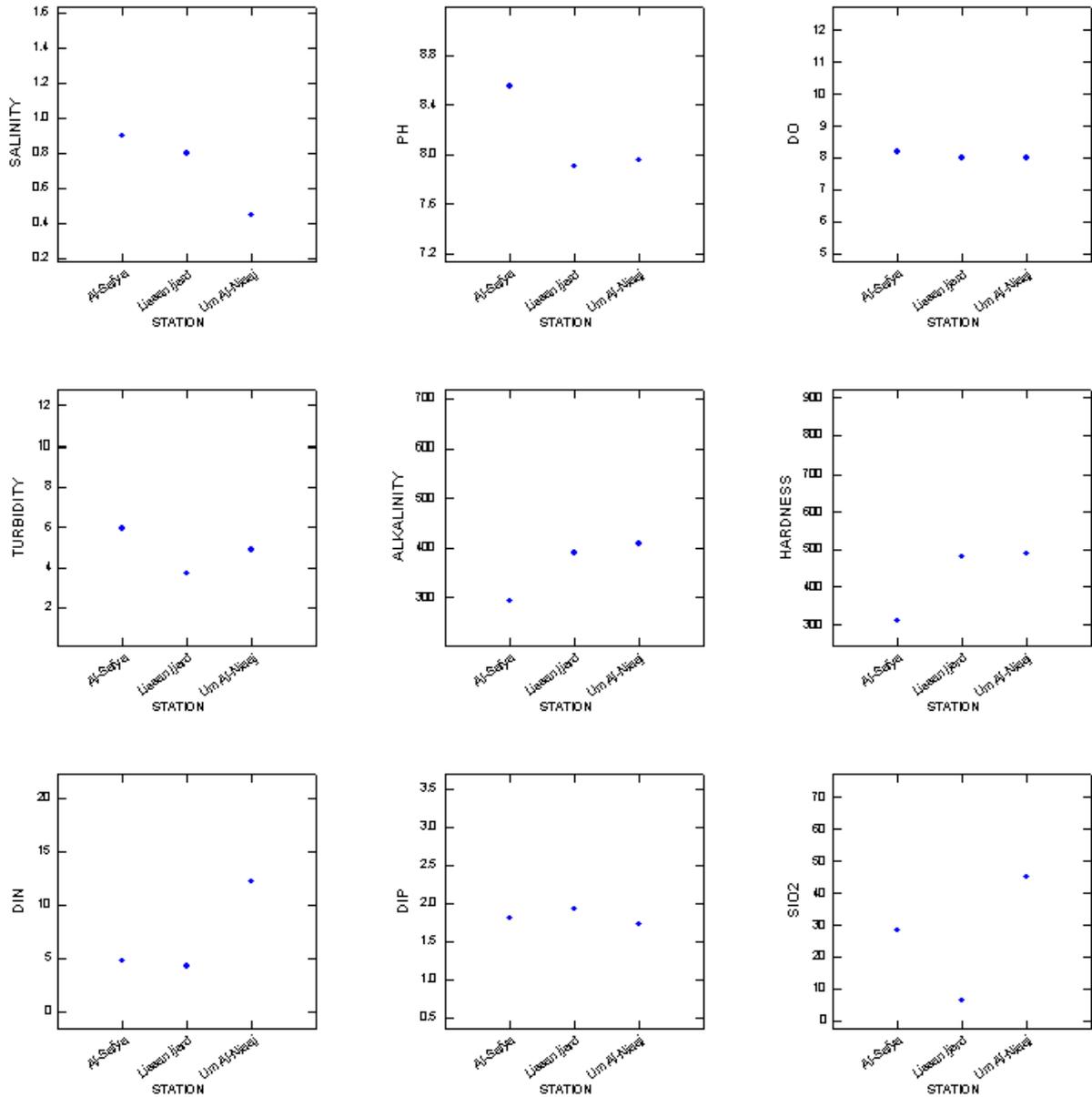


Figure 3. Water quality measurements in the selected marshes of Huweza during the study period

Table 2. Comparison of nutrients values in Huweza marsh with other Iraqi marshes

Marshes sites	Nitrates ($\mu\text{g at N-NO}_2^-/\text{l}$)	Nitrites ($\mu\text{g at N-NO}_3^-/\text{l}$)	Phosphates ($\mu\text{g at P-PO}_4^{3-}/\text{l}$)	Silicates ($\mu\text{g at Si-SiO}_2/\text{l}$)	References
Al-Basrah	0.095	1.63	0.68	190.0	Al-Lammi,1986 Qassim,1986
Um 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 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	
Um Alshwaich	0.130	1.20	1.37	325	
South. marshes	0.680	49.50	3.60	146	Al-Imarah ,2006
Um- Al-Ward	0.206	13.41	2.810	38.58	Al-Saad et al.,2008
Um- Al-Uneach	0.177	10.77	2.614	33.92	
Al- Baghdadiyah	0.182	4.84	0.678	49.04	
Al- Baghdadiyah	0.298	3.67	0.781	27.71	
Al-Nagarah	0.660	1.301	0.750	49.92	
Al-Burka	0.086	1.355	0.712	52.02	
Umm-Al-Niaj	1.064	11.718	1.938	49.504	
Lissan-Ajerda	0.504	5.11	1.85	6.586	Present study
Al-Safiyah	0.708	7.472	1.648	26.038	

Temperature is one of the most important factors, which affect the biota, as well as the other factors. Low temperature reduces metabolic activity, feeding, breeding, respiration and all other activities are influenced by temperature. DO is reduced with rise in WT. Result of present study showed that the AT range from 14.0 – 39.1°C while the WT range from 10.5-29.1°C. AT and WT in all stations showed seasonal variation being high during summer and low during winter. AT at Um al-Niaj ranged from 16.5 -38.8°C and at Lesan Ajerda from 14-39.3°C and at Al-Safya from 24.5-39.1°C. WT recorded the following ranges (11.5-29.2°C), (10.5-29.7°C) and (18.6-29.1°C) in the three above stations respectively.

In general, water of the Iraqi southern marshes is characterized by different temperatures during different seasons of the year. It ranged between 11.9 and 33°C. Lower WT down to 9.9°C was recorded at January 1988 in Al-Hammar marsh [8,9]. No differences or minor differences were recorded between the WT at the surface and lower layers within the water column due to shallowness of the water in the marshes. This contrast in the WT helps in the abundance and growth of different living organism species in the area.

The present findings are in agreement with the previous surveys of Eden Plan Project (2006) for the southern marshes. In this survey, AT was found to be generally increases from north to south across the study area. Average AT also changes by up to 20°C from winter to summer. WT are typically 5°C lower than AT and show the same seasonal variation with a somewhat smaller variability, ranging from about 15°C to 30°C. There are no WT variations from top to bottom since the water is very shallow and/or well mixed and thus homogenous with respect to temperature.

The pH values recorded in the present study were within a narrow range and tend to be alkaline as it is common in Iraqi inland water. This is due to buffering

capacity of Iraqi natural waters with it is relatively high content of calcium bicarbonate [10]. The pH has a unique value range in the basic side between 7 and 9 as those for other Iraqi waters due to the gypsum nature of the bottom and soil of the marshes. The lower value was recorded in Umm-Al-Niaj the mean value 7.3 and higher mean value was 9.0 recorded in Al-Safiya. In general, pH did not change greatly with seasons, generally ranging from 8.1 to 8.3 in the southern marshes, and that's what has been seen in Huweza marsh also. The acceptable range for fish is normally between pH 6.5-9.0. The ideal range for cyprinid fish is above pH 7.0 at around pH 7.5-8.0. All of the marshland waters sampled had alkaline pH which is more acceptable to fish.

Generally, EC in waters referred to dissolved salts [11]. Results from the present work showed that the value of EC ranged from 1.09 in Umm-Al-Niaj to 3.7 ms/cm in Al-Safiya. Low values of EC could be attributed to the dilution of salts due to rainfall. The highest value was probably related to high precipitation and soil leaching processes. The value of EC and salinity recorded were slightly lower than those obtained for the same location before which may be related to dilution factor and climatic condition during the study period [12]. Figure 3 show that the north part of Huweza marsh has lower salt content than the south portion. Salinity ranged from 0.3 ppt to 1.9 ppt. Such phenomenon may be attributed mainly to the uptake of salts by newly flourishing plants like Reed and Typha. Salinity of Huweza marsh waters is initially controlled by its source from the Tigris, and its branches which are the least-saline sources compared with Euphrates and Shatt Al-Arab In general, the lower overall salinities of Huweza marsh and the least range of salinity revealed that the marsh has achieved "hydraulic flow-through" conditions. Parts of the marsh that exhibit higher salinity and higher ranges of salinity, are those where the water enters and stagnates. The salinity of water in the

marshes is important for several reasons. First and foremost is the possibility of using the water for drinking water supplies. Usually, salinity should be less than 0.5 ppt to serve as a human drinking water supply. Secondly, it is important to evaluate whether salinity is appropriate to support wildlife, primarily birds and fish, which have various salinity thresholds. Thirdly, salinity controls the type of vegetation present. Salinity changes can act as an environmental trigger in the marshland, for example causing seed germination. Under salinities higher than 15 ppt seeds of *Phragmites* will not germinate. Seasonal variation was noticed in Huweza marsh, being lower during the period from July-September (0.3 and 0.9 ppt) and higher during February-April (0.6 and 2.0 ppt) in the northern and southern parts respectively. This may be attributed to the flooding and water exchange dynamics.

DO is one of the most important limiting factors, enters an aquatic system through the air – water interface and by the photosynthetic activities of aquatic plants. Thus the amount of DO in aquatic system depends on the rate at which these processes occur. The solubility of DO is influenced by several factors as temperature, dissolved salts and partial pressure of gas as well as inputs of organic matter [13]. Hence the determination of DO is essential. The minimum values of DO (5 mg/l) were recorded in Umm-Al-Niaj and maximum values were 12.25 mg/l recorded in Al-Safya.

Our results referred to high levels of DO recorded in some sites due to aerated, high water levels, well mixing and density of phytoplankton, while the lower values may be due to low water level and degradation of organic matter. Similar conclusions were made by other authors [12,14]. Optimal concentrations of DO are over 5 mg/l; aerobic conditions are above 1 mg/L. Conditions may be considered oxygen deficient at less than 0.5 mg/L, but some organisms can survive down to 0.1 mg/l. According to Eden Master Plan Survey the waters of the Huweza marsh is well oxygenated. Only in some rather confined areas with high organic matter production was oxygen depletion observed. Except in these cases, nearly all of the measurements demonstrated aerobic conditions. Typical oxygenation was around 10 mg/l.

High values of TH were recorded in the present study reflecting a common phenomenon in Iraqi inland water [15]. According to Reid Scale, water of marshlands in Iraq were hard to very hard, ranges of TH were between 570-1930 mg as CaCO₃ mg/l. Lower values were observed in Lesan Ajerda (300mg/l) while maximum values observed in Al-Safiya (1300 mg/l). Spatial variations in total hardness showed large differences among different sites in the marshes, the higher values of total hardness were possibly related to high water level and discharge rate [16] or related to evaporation which increase and concentrate the available cations [17] or due to high precipitation and thus high soil leaching and high current velocities [18], while the lower values related to dilution factor due to precipitation or high water level [17]. In the present study, fluctuation in the level of total hardness was possibly related to change in water discharge rate.

Seasonal and spatial variations are noted in the turbidity values recorded in Huweza marsh during the survey period. Higher turbidity was recorded during the summer months (July, August and September, 2007) ranging between compared with winter and spring months (Feb.,

March and April). Northern part of the marsh exhibited higher turbidity compared with lower reaches. Variations in turbidity are mainly related to the amount of suspended matter occurred in water or the turbulence factors which act locally or seasonally.

In Iraq the total alkalinity mainly due to bicarbonate ions which are abundant in Iraqi inland water [19]. The bicarbonate values recorded in the present study were within the range of 244.04-854 mg/l and agreed with the other studies [19,20]. High level of bicarbonate values recorded were probably related to phytoplankton activity as photosynthesis [21] or due to the organic matter degradation and thus of calcium carbonate [22].

Phosphorus occurs in the number of organic and inorganic compounds in both dissolved and particulate form. The dissolved phase is in the form of orthophosphate, polyphosphate and organic colloidal, while the particulate phase is in the living biota primary algae and higher aquatic plants [23]. Therefore the concentration at any given time is very low [13]. There is fluctuation in the concentration of TP and affected by the number of phytoplankton. Our results referred to high concentration of TP recorded in the April 2008 at Umm-Al-Niaj, while the low values were recorded during July, 2007 at the same location (Figure 3). This is possibly due to additional input from agricultural land nearby or due to activity of phytoplankton, human and industrial effluent loads [12,14,24]. Different factors may affect the concentration of TP in aquatic system these include pH, water flow, adsorption on particulate matter and role of aquatic plants in cycling of phosphorus [12] this concluded that the waters of southern Iraqi marshlands are rich in phosphate which enhance their suitability for growth and billings of aquatic plants and phytoplankton's which are necessary for primary productivity in marshland water and food chain.

A large fraction of TN of fresh water may occur as organic nitrogen in the form of dissolved and particulate organic detritus and generally are not available to photosynthesis organism, they represent major reservoir of nitrogen in aquatic ecosystem [13]. The recorded nitrites were low in the range 0.047 to 3.39 µg at N-NO₂/l at Umm-Al-Niaj, while nitrates characterized by high values which were in the range 0.240 at Lesan Ajerda to 20.01 µg at N-NO₃/l. at Al-Safiya.

Unlike phosphorus, nitrogen occur in a number of very distinct inorganic forms in aquatic ecosystem, N₂, NH₄, NO₂ and NO₃ also occur in a variety of organic forms in aquatic plants [13]. The high concentration of total nitrogen was recorded during the winter, while the lower value was obtained during the autumn. This is possibly related to the change in water temperature and degradation processes [12]. Also the fluctuation in the concentration of total nitrogen depends on nitrogen uptake by phytoplankton and autochemotrophic bacteria.

High levels of SiO₂ were recorded at Umm-Al-Niaj being 58.01 µg at Si-SiO₂/l while low levels were observed at Lesan Ajerda being 4.23 µg at Si-SiO₂/l (Figure 3).

4. Conclusions

The main purpose of the present work was to investigate whether Al-Safya marsh can be designated as a

protected area. Based upon the water quality of Al-Safya marshes in comparison to the healthy Umm Al-Naaj marsh and to a less healthy lisan Ugerda marsh we may thus conclude that Al-Safya marsh is a suitable marsh to be designated as protected area. This recommendation is based on the assumption that the water inflow to Al-Safya is maintained similar to that recorded at the time of monitoring.

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