



## Seasonal Variations of Some Physio-Chemical Parameters of Al-Auda Marsh in Maysan Province

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### Abstract

Seasonally variations in Physio-chemical parameters of Al-Auda Marsh were investigated from November 2012 to July 2013. In this research examine pH, turbidity, EC, DO, BOD<sub>5</sub> and Ca<sup>+2</sup>, Mg<sup>+2</sup>, NO<sub>2</sub>, NO<sub>3</sub>, PO<sub>4</sub>, SiO<sub>3</sub> ions. Six sites were randomly located and water samples. pH values varied from (7.3 ±0.0) in site 4 during autumn to (8.5±0.5) in site 6 during winter, EC values ranged from (2020±186) μ.s/cm in site 5 during autumn to (6390±875) μ.s/cm in site 6 during summer, mean turbidity data were found to vary from (6.5 ±1.8) NTU in site 4 in summer to (31.0 ±1.6) NTU in site 3 in autumn. DO highest mean value (10.9 ± 0.6) was for site 6 in autumn and the lowest value (6.5±0.9) mg/l for site3 in spring. In case of BOD<sub>5</sub> highest and lowest mean values were (4.8 ±0.3) mg/l in site 3 during autumn and (1.2 ±0.3) mg/l in site 2 during winter. Mean Ca<sup>+2</sup> ions ranging from (46±9.4) mg/l in site 4 during autumn to (361±19.6) mg/l in site 1 during summer, mean value of Mg<sup>+2</sup> ion varied from (18 ±9.5) mg/l in site 5 in autumn to (274 ±44.2) mg/l in summer for site 1. Also, mean PO<sub>4</sub><sup>-3</sup> values of varying from (0.01±0.0) mg/l in sample of site 6 during winter to (0.3±0.08) mg/l in sample of site 6 during spring. The mean NO<sub>3</sub> values was varied from (1.8±0.8) mg/l in site 6 during winter to (6.9 ±0.5) mg/l in site 5 during autumn while in case of NO<sub>2</sub> were (0.1±0.0) mg/l in both sites 5 and 6 during spring to (0.35 ±0.01) mg/l in site 1 during autumn. SiO<sub>3</sub> data found to vary from (1.0±0.5) mg/l in site 6 during autumn to (6.35 ±0.5) mg/l in site 2 during summer.

**Key words :** Al-Auda marsh, physical variables, DO,BOD<sub>5</sub>, inorganic ions.

### التغيرات الفصلية لبعض البراميترات الفيزيوكيميائية لهور العودة في محافظة ميسان

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### الخلاصة :

درست التغيرات الموسمية للخصائص الفيزيائية - الكيميائية لهور العودة مثل الدالة الحامضية، العكارة ، والتوصيلية الكهربائية ، الاوكسجين المذاب ، المتطلب الحيوي للاوكسجين ، أيونات الكالسيوم ، المغنيسيوم ، النترات، النتريت ، الفوسفات ، السيلكا . تم اختيار ستة مواقع عشوائيا " ضمن الهور وجمعت عينات المياه للفترة من تشرين الثاني 2012 إلى تموز 2013. معدل قيم pH تباينت من (0.0±7.3) في الموقع 4 خلال الخريف إلى (0.5 ± 8.5) في الموقع 6 في الشتاء، تراوحت قيم EC من (186 ± 2020) μ.s / سم في الموقع 5 خلال الخريف إلى (875 ± 6390) μ.s / سم في الموقع 6 في الصيف. معدل

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العكارة كان متباين من NTU (1.8 ± 6.5) في الموقع 4 خلال الصيف إلى NTU (1.6 ± 31.0) في الموقع 3 في الخريف. معدل أعلى قيمة لل DO (0.6 ± 10.9) ملغم / لتر في الموقع 6 خلال الخريف وأقل قيمة (0.9 ± 6.5) ملغم / لتر في الموقع 3 خلال الربيع. في حالة BOD<sub>5</sub> فان معدل أعلى وأدنى القيم كان (0.3 ± 4.8) ملغم / لتر في الموقع 3 خلال الخريف و (0.3 ± 1.2) ملغم / لتر في الموقع 2 خلال الشتاء. معدل ايونات Ca<sup>+2</sup> تراوحت من (9.4 ± 46) ملغم / لتر في موقع 4 خلال الخريف إلى (361 ± 19.6) ملغم / لتر في الموقع 1 في الصيف، معدل قيمة ايونات Mg<sup>+2</sup> تباينت من (9.5 ± 18) ملغم / لتر في الموقع 5 خلال الخريف إلى (44.2 ± 274) ملغم / لتر في الصيف للموقع 1، كذلك قيمة PO<sub>4</sub><sup>-3</sup> كانت متفاوتة من (0.0 ± 0.01) ملغم / لتر في عينة الموقع 6 خلال الشتاء إلى (0.08 ± 0.3) ملغم / لتر في عينة الموقع 6 خلال الربيع. وقد تباينت قيم NO<sub>3</sub><sup>-1</sup> من (0.8 ± 1.8) ملغم / لتر في الموقع 6 خلال الشتاء إلى (0.5 ± 6.9) ملغم / لتر في الموقع 5 خلال الخريف، بينما كانت قيم NO<sub>2</sub><sup>-</sup> من (0.0 ± 0.1) ملغم / لتر في كلا الموقعين 5 و 6 خلال الربيع إلى (0.0 ± 0.35) ملغم / لتر في الموقع 1 في الخريف و قيم SiO<sub>3</sub> كانت مختلفة من (0.5 ± 1.0) ملغم / لتر في الموقع 6 خلال الخريف إلى (0.5 ± 6.35) ملغم / لتر في الموقع 2 خلال الصيف.

### Introduction:

Marshlands are generally defined as wetlands inundated in water continuously or frequent characterized by prominent vegetative cover emerge herb by soft legs, and which adapts to water saturated soil conditions which remains at or above the level of water permanently or temporarily [1].

The Iraqi marshlands constitute the largest wetland ecosystem in the middle east and western eurasia. These marshes covered more than 15,000 km<sup>2</sup>. However, Iraqi marshes often referred to as the "Garden of Eden" having been the cradle of Western civilization [2- 4].

In 2002, 85% of permanent marshes defined in 1973 had been totally destroyed, and only 3% of the central marshes, 14.5% of the Hammar marshes and 35% of the Hawizeh marshes remained [5-6]. In other words the total area of the permanent marshes was about 9000 km<sup>2</sup> in 1973 while these marshes left to cover about only 760 km<sup>2</sup> after last years of previous century [6-7].

Hour Al-Auda forms part of mesopotamia wetlands. Al-Auda marsh was drained during 1990's and in 2003 it has been re-inundated a total area of (50%). An area of about (7,500 ha), length 20 km, width 10 km and up area 105 km<sup>2</sup> [8].

The present study was aimed to examine water physical and chemical parameters such as temperature, turbidity, EC, pH, DO, BOD<sub>5</sub>, Ca<sup>+2</sup>, Mg<sup>+2</sup>, NO<sub>2</sub><sup>-1</sup>, NO<sub>3</sub><sup>-1</sup>, PO<sub>4</sub><sup>-3</sup>, SiO<sub>3</sub>.

### Materials and Methods

Al-Auda marsh (Latitude/ Longitude : 31°33'N, 46°51'E) is one of the water bodies located in Maysan province southern Iraq. Approximately 35 km of Al-Ammara city in Maysan province and it is 5 km away from Al-Maymuna district. It is one of the marshes in western side of Tigris River within Maysan province.

Six randomly sites within Al-Auda marsh were selected. Site 1 were (Braidah), GPS reading (N: 31 36 25, E: 46 50 10), site 2 were (Al-Adla), GPS reading (N: 31 35 22, E: 46 50 25), site 3 were (Center Al-Auda marsh), GPS reading (N: 31 34 30, E: 46 49 47), site 4 were (Al-Auda), GPS reading (N: 31 34 55, E: 46 51 13), site 5 were (UM Al-Meshahef), GPS reading (N: 31 33 49, E: 46 52 07) and site 6 were (Al-Battat), GPS reading (N: 31 32 55, E: 46 54 09) shown in Figure 1.

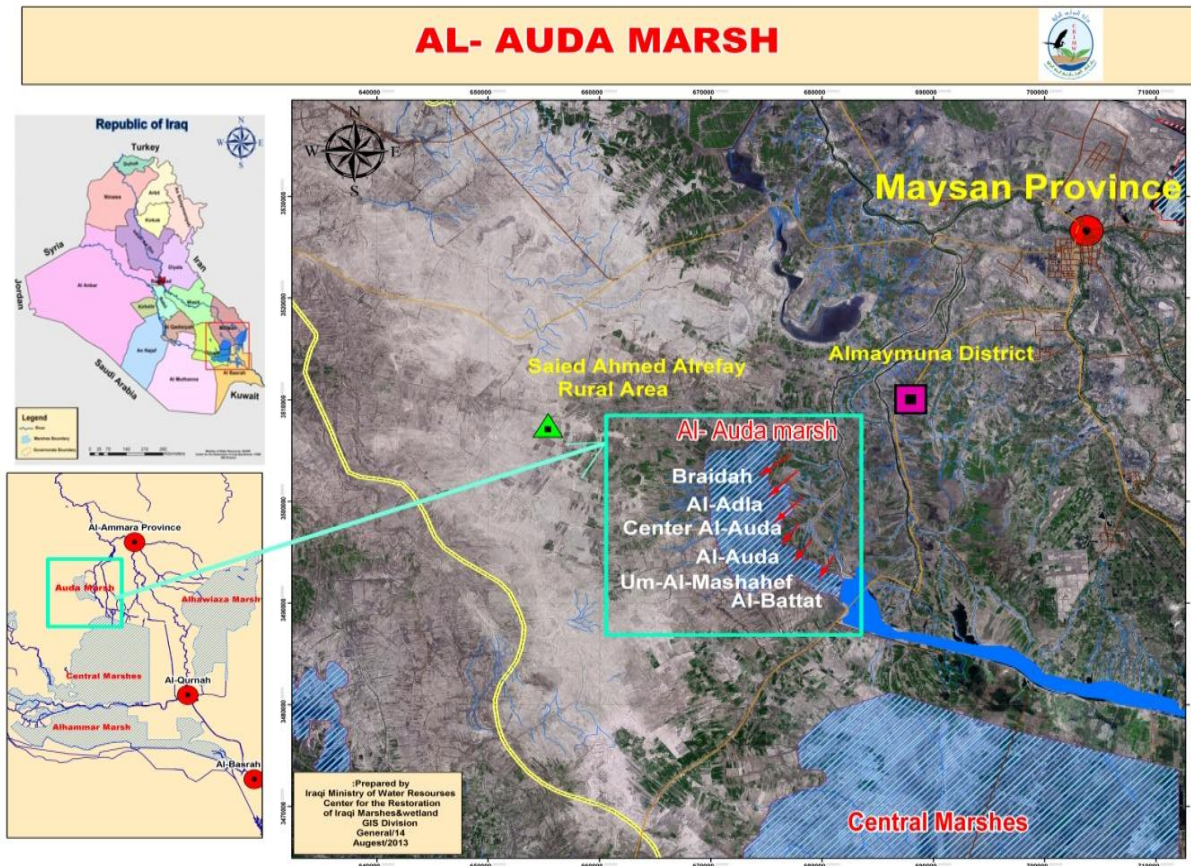


Figure 1- Location of Al-Auda marsh in Maysan province southern Iraq. Source CRIM,(2013).

Water sampling was carried out from six sites once a month for the period of November 2012 to July 2013. Water samples were collected from each site 20-30 cm beneath water surface using various volume containers where a 100 ml polyethylene containers were used for the reactive silicate test while Duran glass containers (500ml capacity) used to measure the other nutrients (dissolved nitrate, dissolved nitrite and dissolved reactive phosphate). Also polyethylene containers (2 liters) were used for collecting water samples for the analysis of turbidity, calcium and magnesium ion concentrations. However, further sterile dark Winkler bottles (250ml) for water samples to be used for the tests of dissolved oxygen and biological oxygen demand.

## Results and Discussion

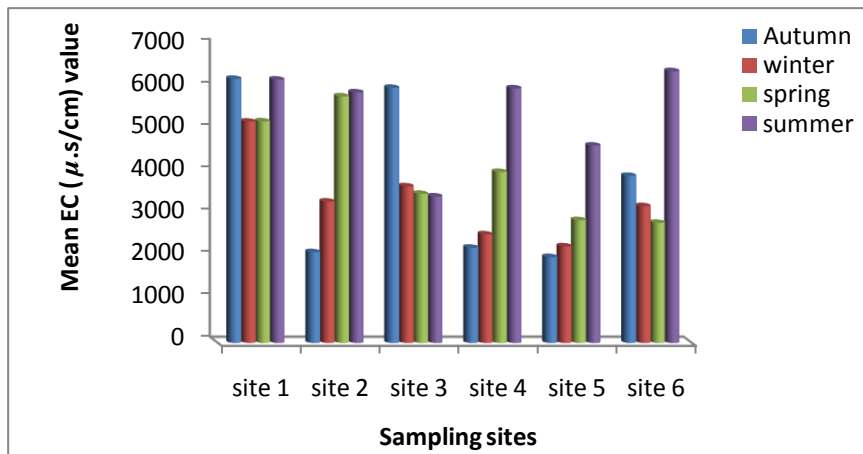
Table-1 shows mean value  $\pm$  Sd of pH , turbidity (NTU) , EC ( $\mu$ .s/cm) , DO (mg/l) , BOD<sub>5</sub> (mg/l) and Ca<sup>+2</sup>, Mg<sup>+2</sup>, NO<sub>2</sub><sup>-1</sup>, NO<sub>3</sub><sup>-1</sup>, PO<sub>4</sub><sup>-3</sup>, SiO<sub>3</sub> ions in water samples collected from six studied sites within Al-Auda marsh from November 2012 to July 2013.

Values of pH were found to range from 7 to 8.5. These data are expected for Iraqi waters due to the gypsum nature of the bottom and soil of the marshes. However, similar studies [9-11] have reported almost similar results.

For EC , the current results showe that the lowest value (2020 $\pm$ 186 $\mu$ .s/cm) was recorded in site 5 during autumn, while the highest value (6390 $\pm$ 875 $\mu$ .s/cm) were found in site 6 during summer season in Figure-2. Seasonal variations in water conductivity may be linked to water decreasing levels and increasing of evaporation ratio as suggested by different studies [12-14].

**Table 1-** Shows mean value ± SD of physical and chemical characteristics of water samples collected from six sites within Al-Auda marsh during study period.

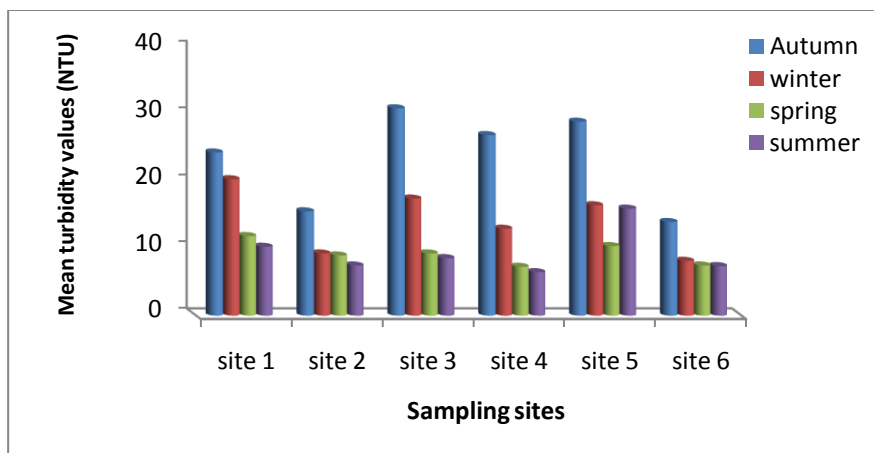
Season	Site	Mean ± SD										
		Tur.(N TU)	pH	EC (u.s/c)	DO (mg/l)	BOD <sub>5</sub>	Ca <sup>+2</sup> (m g/l)	Mg <sup>+2</sup> (m g/l)	PO <sub>4</sub> (m g/l)	NO <sub>3</sub> (m g/l)	NO <sub>2</sub> (m g/l)	SiO <sub>3</sub> (mg/l)
Autumn	1	24.4 ±0.5	7.5 ±0.0	6210±245	8.5 ±0.3	3.6 ±0.1	272±10.5	225 ±13.3	0.09 ±0.01	4.3 ±0.9	0.35 ±0.01	1.8 ±0.3
	2	15.6±0.8	7.7±0.2	2135±350	9.5±0.0	1.8±0.0	138±7.8	71.4±1.4	0.15±0.03	5.9±0.6	0.33±0.0	2.5±0.6
	3	31.0 ±1.6	7.5 ±0.6	5998±325	8.2 ±0.7	4.8 ±0.3	302±3.2	192 ±20.0	0.2 ±0.05	4.3 ±0.4	0.3 ±0.02	1.2 ±0.1
	4	27.0 ±2.4	7.3 ±0.0	2240±198	10.0 ±0.4	2.5 ±0.1	46±9.4	31 ±14.1	0.18 ±0.02	6.7 ±0.8	0.29 ±0.0	4.2 ±0.4
	5	29.0 ±2.2	7.5 ±0.3	2020±186	9.5 ±0.2	2.3 ±0.4	56±12.6	18 ±9.5	0.1 ±0.0	6.9 ±0.5	0.25±0.03	5.1 ±0.2
	6	14.0±2.6	8.4±0.5	3928±328	10.9±0.6	3.6±0.2	173±1.0	133±10.8	0.2±0.01	2.8±0.1	0.2±0.0	1.0±0.5
Winter	1	20.4 ±2.5	8.1 ±0.4	5203±780	9.5 ±0.8	2.8 ±0.5	242±1.9	158 ±24.5	0.09 ±0.02	2.4 ±1.3	0.2 ±0.04	1.6 ±1.3
	2	9.3±1.8	8.0±0.2	3323±587	9.9±0.5	1.2±0.3	186±5.0	130±39.0	0.07±0.04	3.8±0.8	0.23±0.08	2.2±1.6
	3	17.5±1.4	8.0 ±0.0	3681±310	9.1 ±0.6	2.4 ±0.4	202±4.6	117 ±22.4	0.2 ±0.1	3.75 ±1.5	0.28 ±0.02	1.49 ±2.3
	4	13.0±1.6	8.0 ±0.2	2553±170	9.7 ±0.2	1.7 ±0.8	161±39.5	78 ±10.4	0.08 ±0.0	3.93 ±1.7	0.21 ±0.09	1.74 ±0.6
	5	16.5±1.4	8.0 ±0.4	2270±188	9.9 ±0.4	2.6 ±0.4	160±10.4	60 ±18.8	0.05 ±0.01	4.67 ±1.9	0.21 ±0.08	3.53±1.4
	6	8.2±1.6	8.5±0.5	3217±205	10.8±0.5	2.6±0.7	167±7.6	99±26.0	0.01±0.0	1.8±0.8	0.28±0.05	5.97 ±1.7
Spring	1	11.9 ±2.0	7.9 ±0.8	5209±177	8.7 ±0.8	3.0±0.6	295±16.5	163 ±46.4	0.12±0.07	2.93 ±0.7	0.11±0.06	4.37±1.8
	2	9.0±1.2	7.8±0.6	5796±210	8.5±0.4	2.5 ±0.9	333±44.4	166±37.5	0.09 ±0.05	3.37±0.2	0.12 ±0.08	4.43±0.5
	3	9.3±2.5	7.6±0.9	3506±208	6.5±0.9	2.1±0.3	223±27.0	134±15.8	0.12±0.06	4.2±1.1	0.13±0.05	3.7 ±0.4
	4	7.3±2.0	7.7±0.5	4020±185	8.6±0.5	2.6±0.8	247±35.6	135±12.7	0.09±0.02	3.03±0.9	0.11±0.03	3.73±0.6
	5	10.4±2.0	8.2±0.3	2887±200	9.1±0.6	1.7±0.8	158±31.0	84±20.2	0.26±0.03	5.03±1.6	0.1±0.0	5.67±0.8
	6	7.5±1.4	8.1±0.4	2825±198	8.7±0.8	3.3±0.9	159±14.8	57±13.0	0.3±0.08	1.97±0.8	0.1±0.0	3.93±1.2
Summer	1	10.3 ±2.3	7.6 ±0.0	6191±440	8.4 ±0.9	3.0±0.7	361±19.6	274 ±44.2	0.12±0.0	3.4 ±0.0	0. ±2+0.1	3.9±2.2
	2	7.5 ±3.4	7.6 ±0.5	5890±375	9.1 ±0.7	3.2 ±0.8	310±2.8	196 ±38.5	0.14 ±0.03	3.25 ±0.3	0.2 ±0.1	6.35±0.5
	3	8.6 ±0.6	7.7 ±0.1	3445±190	7.4 ±0.1	3.4 ±0.9	334±28.5	106 ±26.0	0.12 ±0.05	2.15 ±0.1	0.18 ±0.09	3.75 ±0.8
	4	6.5 ±1.8	7.7 ±0.0	5985±315	8.4 ±0.8	4.6 ±0.2	346±30.0	258 ±9.8	0.12 ±0.06	2.05 ±0.6	0.3 ±0.0	4.85 ±0.1
	5	16.0 ±1.4	7.7±0.4	4640±130	9.2±0.6	2.0 ±0.5	268±43.7	150±18.9	0.15 ±0.0	1.95±0.5	0.2 ±0.0	6.05 ±0.6
	6	7.4 ±0.5	7.7 ±0.3	6390±875	7.0 ±0.5	2.6±0.4	309±24.0	211 ±31.5	0.12±0.7	2.2 ±0.4	0.25±0.03	3.3 ±1.9



**Figure 2-** Mean EC value( $\mu.s/cm$ ) of water samples collected from six sites within Al-Auda marsh

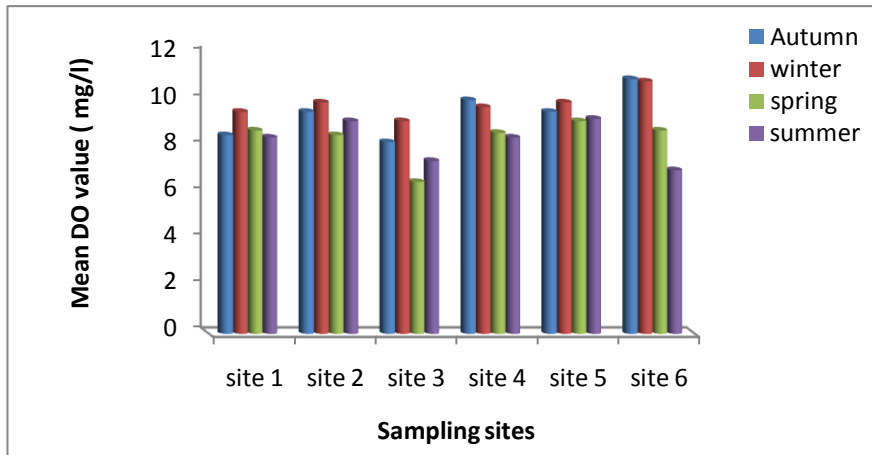
Mean turbidity results from water samples of all examined sites during study period are presented in Figure 3. This means values were found to vary from  $6.5 \pm 1.8$  NTU in site 4 during summer to  $31.0 \pm 1.6$  NTU in site 3 during autumn. In general, the seasonal variations in the turbidity values were clear where maximum values were found in autumn and winter while the minimum values were recorded in summer in all studied sites.

This may be due rainfall in these seasons which causes erosion for edges of rivers and marsh. Another reason could be due to the probable river flooding and thus the flow of large amounts of water across Al-Haddam River and all the branches that feeding Al-Auda marsh. Also the movement of fishermen boats may be another cause as well as to fishermen who use toxic materials for fishing. In general, similar findings were reported by different works of similar marsh environments [15,16] .



**Figure 3-** Mean turbidity (NTU) of water samples collected from six sites within Al-Auda marsh

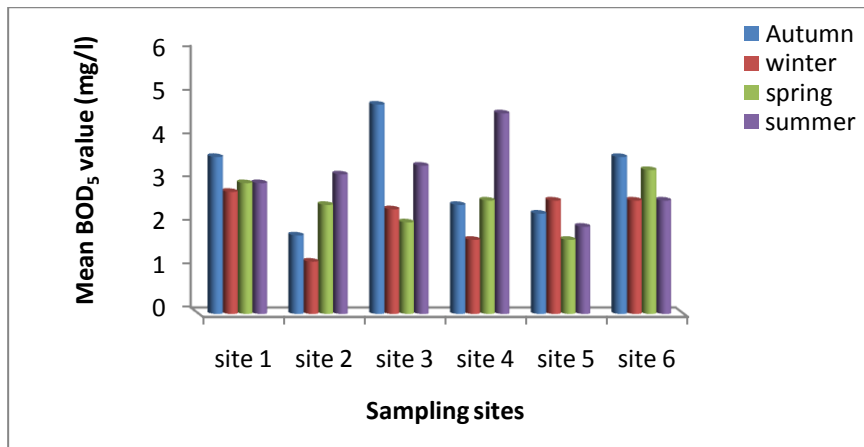
In case of dissolved oxygen, this study has found that the mean dissolved oxygen values were varied from  $6.5 \pm 0.9$  mg/l in site 3 during spring to  $10.9 \pm 0.6$  mg/l in site 6 during autumn in Figure 4. However, the maximum values were found in winter while the minimum values were in summer in all examined sites.



**Figure 4-** Mean DO value (mg/l) of water samples collected from six sites within Al-Auda marsh

There are many factors may play an important role linked to dissolved oxygen such as photosynthesis and aquatic organisms respiration as suggested by similar work [17]. Also, rising temperature may lead to decline dissolved oxygen concentration in water [18,19]. In addition to the nutrients materials [20] and the levels of EC particularly in summer [15,21]. In the other hand the highly of Electrical Conductivity (EC) values at summer that led to decreasing the solubility of oxygen gas in water.

Regarding biological oxygen demand ( $BOD_5$ ), the obtained results showed that the mean value was varied from  $1.2 \pm 0.3$  mg/l in sample collected from site 2 during winter to  $4.8 \pm 0.3$  mg/l in water sample of site 3 during autumn in Figure 5.

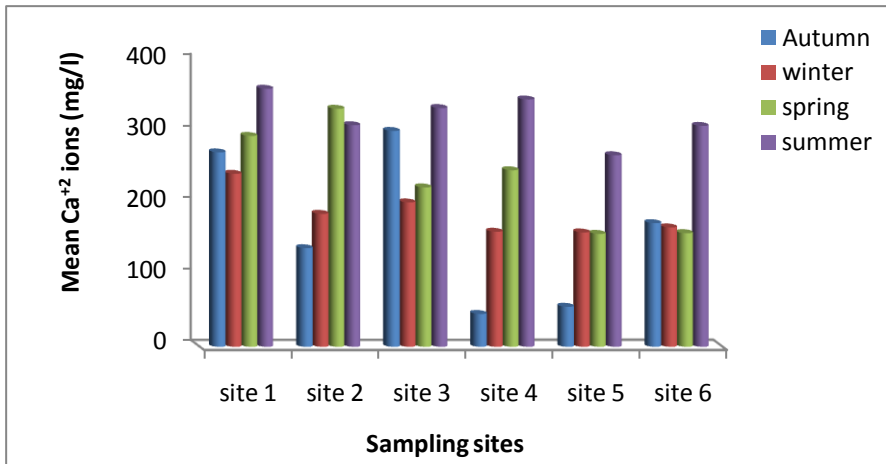


**Figure 5-** Mean  $BOD_5$  value (mg/l) of water samples collected of six sites in Al-Auda marsh

Lower  $BOD_5$  values may be caused by two reasons, firstly there are no industrial activities that throw pollutants directly to the marsh and the human pollution is extremely low because limited villages surrounding Al-Auda Marsh. Secondly the spreading of plants and flow slow water that contributes to decrease  $BOD_5$  concentration as recommended by [22].

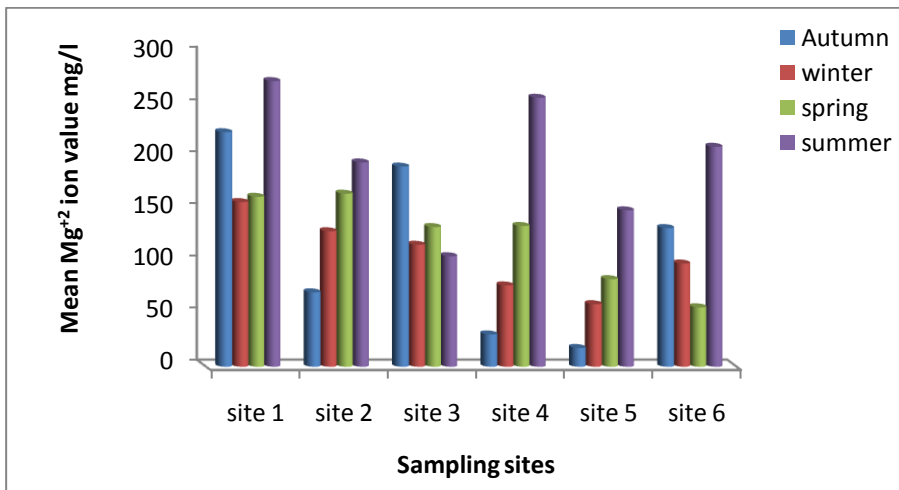
By contrast, higher  $BOD_5$  values in autumn and summer may due to increasing water temperature which increases organic substances decay and leading to decrease in DO value as suggested by previous study [23].

Data of calcium ions are presented in Figure 6 .  $Ca^{+2}$  ions values were found to range from  $46 \pm 9.4$  mg/l in site 4 during autumn to  $361 \pm 19.6$  mg/l in site 1 in summer. It is well known that these ions form the major inorganic, positive ions in freshwater ranging from zero to several hundred milligrams per liter depending on the source and treatment of the water [24]. It could be originate from the dissociation of salts, such as calcium chloride or calcium sulfate.



**Figure 6-** Mean Ca<sup>2+</sup> ions (mg/l) of water samples collected from six sites within Al-Auda marsh

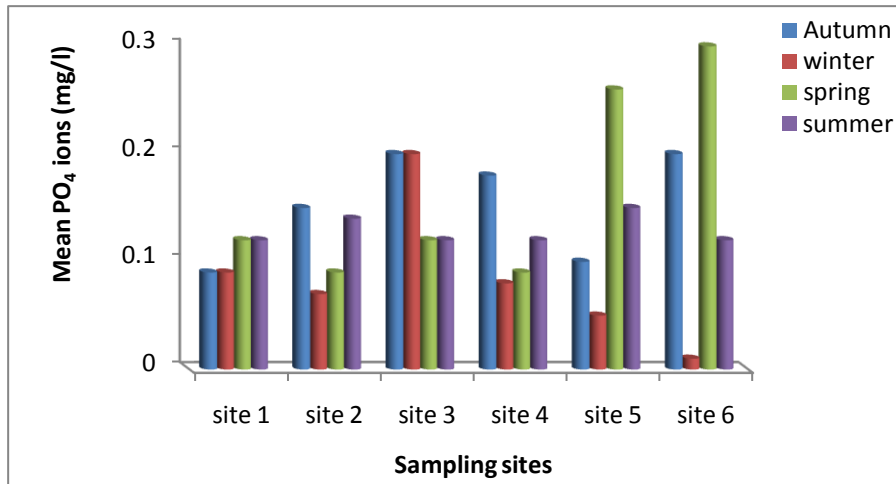
In case of magnesium ions (Mg<sup>2+</sup>), the data were displayed in Figure 7 . The highest mean value (274 ±44.2 mg/l) was recorded in site 1 during summer while the lowest (18 ±9.5 mg/l) in autumn for site 5.



**Figure 7-** Mean Mg<sup>2+</sup> ions value (mg/l) of water samples collected from six sites in Al-Auda marsh

Hardness of water depends on the amounts of calcium and magnesium salts dissolved in water, in addition to several seasonal variations factors such as evaporation, rainfall and the amount of discharges [25]. In general, highest values of both Ca<sup>2+</sup> and Mg<sup>2+</sup> ions were found in site 1 during summer while declined mean values again of both ions were found in sites 4 and 5 respectively during autumn.

Figure 8. Shows mean value of PO<sub>4</sub> ions of water samples from all examined sites collected during the current work.



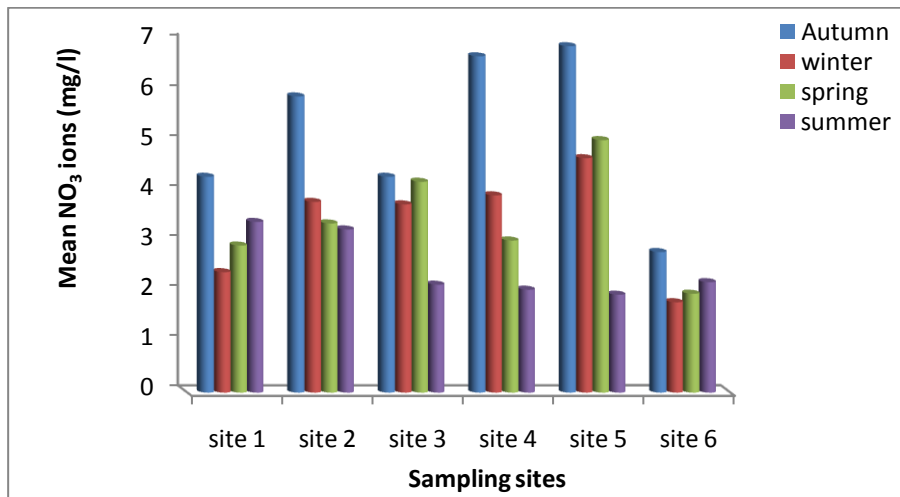
**Figure 8-** Mean PO<sub>4</sub> value (mg/l) of water samples collected from six sites in Al-Auda marsh

The current results showed mean value of reactive phosphate (PO<sub>4</sub><sup>-3</sup>) in all studied sites were varied from 0.01±0.0 mg/l in site 6 during winter to 0.3±0.08 mg/l again in site 6 but during spring.

Apparently, maximum PO<sub>4</sub><sup>-3</sup> values were recorded in spring while the minimum values were found in winter. This may be due to climatic factors such as rain and dust particles suspended in the atmosphere as a result of human activities [26] and also may be related to organic waste of certain animals such as water buffalo and birds [27] or may due to the leaching agricultural residuals [28].

In the other hand, the lower PO<sub>4</sub><sup>-3</sup> concentrations may due to the dilution caused by rainfall and flooding in addition to the increased uptake by aquatic plants [29] and phytoplankton during this season [30].

Regarding nitrate and nitrite ions, the results of this study showed that the mean nitrate values was varied from 1.8±0.8 mg/l in site 6 during winter to 6.9 ±0.5 mg/l in site 5 during autumn in Figure 9.

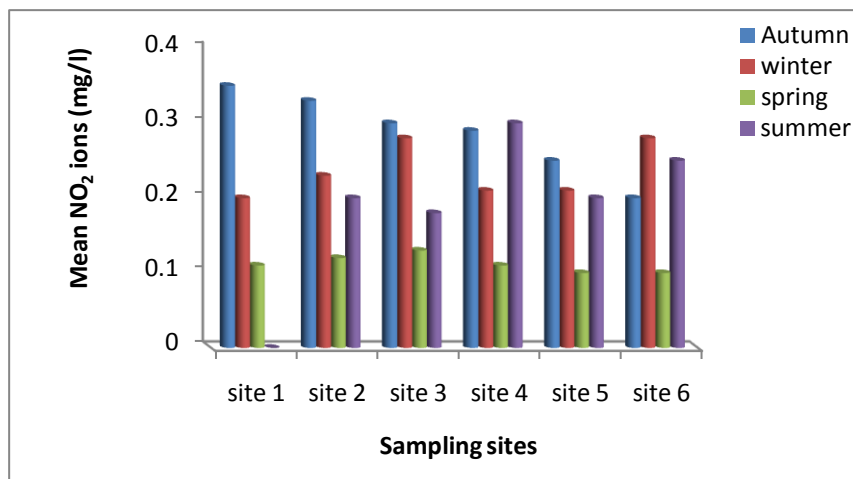


**Figure 9-** Mean NO<sub>3</sub> ions (mg/l) of water samples collected from six sites in Al-Auda marsh

It seems clearly that the maximum values were in autumn season while the minimum values were in winter season. However, this variation may be due to the amounts of nitrate being taken by the aquatic plants and phytoplankton and to the decreasing water levels during this season as have been reported by different studies [14,31,32].

In case of nitrite ions, the mean values was varied from 0.1±0.0 mg/l in both sites 5 and 6 during spring to 0.35 ±0.01 mg/l in site 1 during autumn in Figure 10.

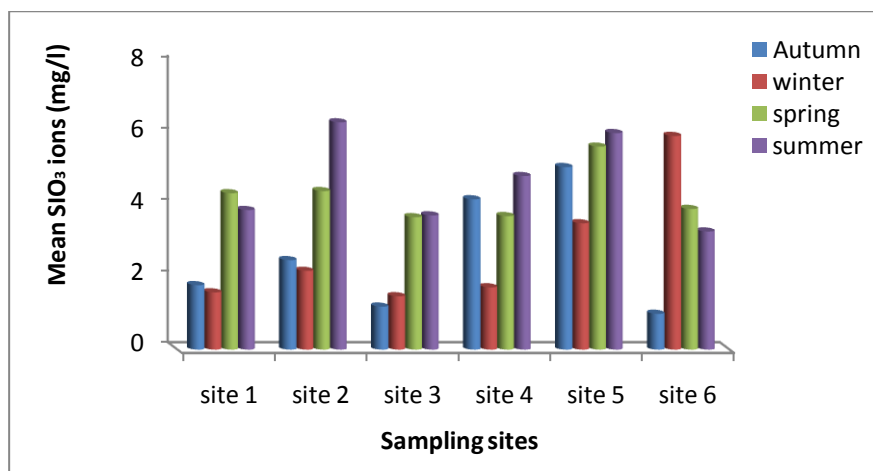




**Figure 10-** Mean NO<sub>2</sub> ion value (mg/l) of water samples collected of six sites in Al-Auda marsh

This study showed clear seasonal changes in concentration of NO<sub>2</sub><sup>-</sup> during the study period, where the maximum values observed in autumn while the minimum values were in spring. This may be due to the reduction of the nitrate to nitrite and to increasing the solubility of the organic materials in autumn and winter [33,34] and to erosion of some amounts by rainfall water from rivers and marshes banks. Also, in this season the uptake of the nitrite by the aquatic plants and phytoplankton is extremely limited [35,36].

Data of Silica or silicon trioxide (SiO<sub>3</sub>) is shown in Figure 11. It seems clearly that the mean values of SiO<sub>3</sub> were higher in summer and much lower in autumn. In general, the data were found to vary from 1.0±0.5 mg/l in site 6 during autumn to 6.35 ±0.5 mg/l in site 2 during summer.



**Figure 11-** Mean SiO<sub>3</sub> ion value (mg/l) of water samples of six sites in Al-Auda marsh

Seasonal variations however may be due to the dilution of water by rainfall and to the uptake by the diatoms that consume large amounts of reactive silicate in building structures [37] and higher plants [38]. Also, water temperatures which affect the release of silicon from sediments as reported by several works [39,40,41].

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