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The Effect of Environmental Variables on the Distribution of some Submerged Aquatic Plants Eastern Al-Hammar and Al-Chebiyesh

The Effect of Environmental Variables on the Distribution of some Submerged Aquatic Plants Eastern Al-Hammar and Al-Chebiyesh

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Abstract. This study aims to determine some physical and chemical factors and their impact on the abundance and distribution of some submersible aquatic plants for four selected stations in the southern marshes, two stations in the Eastern Hammar marshes (Al-Burga and Al-Sada) and two stations in the Al-Chebiyesh marshes (Abu- Sobat and Al-Baghdadia). Water and plant samples were collected seasonally during the year 2018. The water temperature, electrical conductivity, water depth were estimated physical variables, dissolved oxygen, nitrate, and phosphate concentration as well as chemical variables for water samples, as well as estimation of biomass, percentage of vegetation cover, and frequency of submerged plant species. The results showed that the highest water temperature was 34.45 °C in the Abu Sobat station during the summer, while the lowest temperature was recorded at 10.85 °C in the Al-Burga station during the winter. The highest depths of water during the winter in the Al-Sada station and the lowest depths in Al-Baghdadia station during the summer. The lowest value of dissolved oxygen was 4 mg/L in Al-Baghdadia during the summer, while the highest value was 9. The biomass, vegetation cover, and frequency were estimated for four plant species, which are the most present and widespread in the various study stations, which are included*Ceratophyllum demersum*, *Myriophyllum spicatum*, *Najas marina*, *Potamogeton perfoliatus.* The percentage of similarity between the different study stations was also calculated.

Keywords. Al-Hammar Marsh, Al-Chebiyesh marsh, Aquatic plants, Physical and chemical parameters.

1. Introduction

The study of the physical and chemical characteristics of water is an urgent necessity, since water is the basic environment for aquatic organisms, including aquatic plants, which are affected by a group of environmental factors that include physical factors (which include light, temperature, and water movement), chemical factors that include nutrients, salinity, dissolved gases, pH [1]. Biological factors (grazing, competition, productivity, and human intervention), these factors have independent or overlapping effects on plant distribution, diversity, and productivity [1,2]. Temperature is one of the main factors affecting the aquatic environment and the living organisms, and it contains in particular, and any change to this factor from the normal limit leads to a change in the activity and effectiveness of living organisms, it leads to flowering and growth of plants increased in the spring and summer seasons due to the increased activity of the photosynthesis process, and the temperature also works to determine the depth at which the plants grow. Temperature may be a limiting factor for plant growth [3]. The decrease in the seasonal growth of aquatic plants results from a decrease in temperature [4]. Plant productivity decreases with a decrease in temperature due to a decrease in photosynthesis rates [5], while [6] indicated that the increase in a sudden temperature may cause premature aging of plants through its effect on the germination process, while many researchers showed that aquatic plants have the ability to adapt to heat [7, 8, 9]. *Sparganium emersum* grows during summer while some aquatic plant species such as *Luronium natans* (L.) Raf., *Berula erecta* Huds., *Hippuris vulgaris* L. They are evergreen and reproduce during the winter in cold waters [10].

The pH is one of the most important environmental characteristics that affect the survival, metabolism, physiology and growth of various aquatic organisms [11], it has an important role in the aquatic environment, which is evident through its effect on organisms that live in specific ranges of pH [12,13], showed that pH represents a determining factor for the growth and composition of plant communities, In Ohio, the pH values of the Lamnaceae family in rivers are between (5.6-8.8) and the species die at a pH of 2.1. The pH is an important factor in determining the richness of plant species in Lake Finnish Hiidenvesi [14], while [15] demonstrated that *Apium nodiflorum* Lag presence was associated with an inverse relationship with the pH values, and it was found to grow within a range between (5.1-8.8).

The source of dissolved oxygen in water surfaces is the atmosphere, and aquatic plants play a role in supplying water with it through the process of photosynthesis [16], and oxygen gas is of particular importance to many aquatic organisms [17], importance of the dissolve oxygen in water is regulates the bio actions of aquatic organisms and is indispensable even if its concentration drops below a certain level to sustain aquatic life [18]. Dissolved oxygen is one of the environmental factors that clearly affected the distribution of aquatic plants within 28 lakes belonging to the Karst region in Slovenia [19]. The density of plant species was observed in areas with high concentrations of oxygen and its absence at low concentrations, which ranged between (0.2-14) mg / L. [20] mentioned that there is a gradient in the photosynthesis process of plant species due to changes in oxygen concentration in one of the coastal lakes in western Greece.

The distribution and growth of aquatic plants is related to the level of nutrients in the environment, especially nitrate and phosphate [21]. Many studies have shown that high levels of nutrients can cause significant changes in the composition, density and richness of aquatic plant species in water surfaces [22-24]. Species richness, and vegetation composition of the submersible plants decrease in the lower part of the Danube River due to eutrophication [25]. Although many nutrients are involved in plant growth, nitrogen and phosphorus are the main elements required for the growth of aquatic plants, and their availability controls primary productivity in freshwater ecosystems, lakes and seas, the concentration of nitrates is a determining factor for the productivity of phytoplankton and aquatic plants in wetlands, while phosphates are a determining factor for the productivity of phytoplankton in seas and lakes due to the difference in depths, as the depth of the marshes is shallow in the marshes, this allows phosphates to return to the water column when the movement of light waves due to the wind [26]. several of studies were conducted in the marshes of East Al-Hammar and Al-Chebiyesh in the southern part of Iraq, dealing with the water quality and submerged aquatic plants, their quantitative characteristics, and the Influence of environmental factors on their diversity and presence in those areas, such as [1,2,18,34,43-46].

2. Materials and Methods

2.1. Study Stations

The study was done in the college of science, Department of Biology, Basrah University. Four different stations were chosen in the southern marshes (Fig. 1). Two stations were in the eastern Al-Hammar marshes, namely Al-Sada and Al-Burga, and two stations in the Al-Chebiyesh marshes, namely Abu Sobat and Al-Baghdadiya. The coordinates of these stations were determined using a device GPS as shown in the (Table 1; Figure 1).

Table 1. Coordinates of the study stations.

T	Station	Coordinates
1	Al-Sada	N30˚36.556'E047˚40. 276'
2	Al-Burga	N30˚41.067' E 047˚34. 955'
3	Abu-sobat	N30˚58.694' E 047˚02. 436'
4	Al-Baghdadiya	N31˚02.931' E 047˚02. 198'

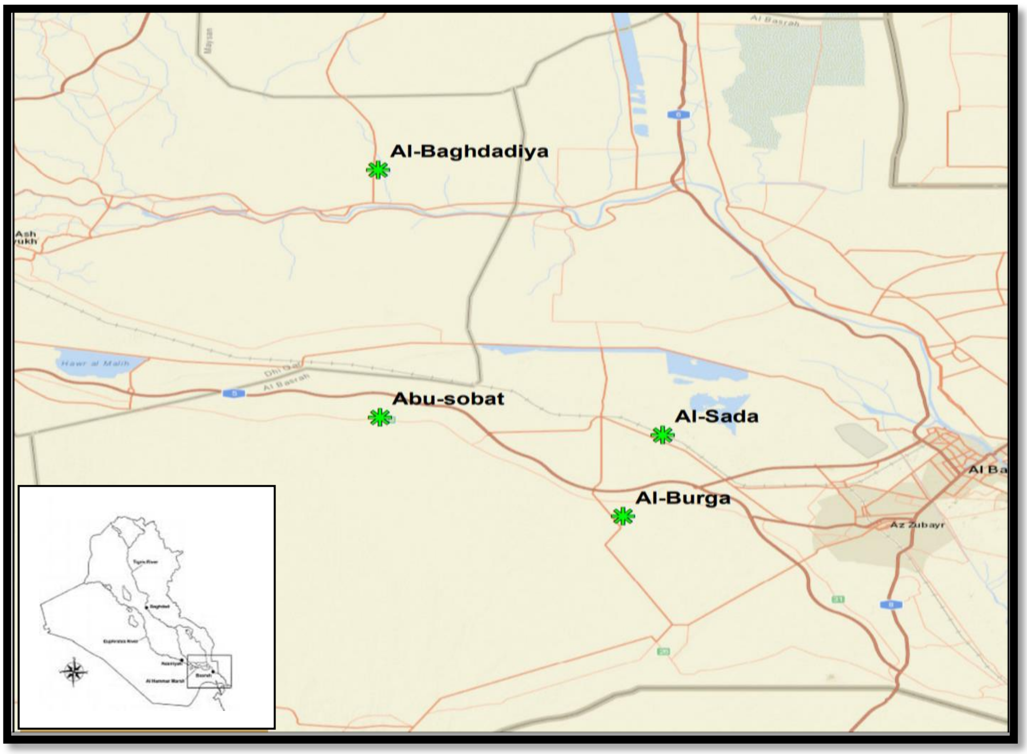

Figure 1. A map showing the study stations.

2.2. Samples Collection

Samples were collected to study the environment and diversity of aquatic plants from different study stations during daylight hours quarterly for the period from February 2018 to December 2018. Polyethylene bottles were used to collect water samples with three replicates from each station, which were taken randomly, then the samples were placed in a container dark and transported to the laboratory and kept at a temperature of 4 ° C. Samples of aquatic plants were collected after washing them with marsh water suspended matter. They were kept in large plastic bags. All information of plant species, place and date of collection was recorded, and then kept in the herbarium of the University of Basrah (BSRA) in the College of Science / University of Basrah.

2.3. Measure Environmental Factors

2.3.1. Water Temperature

A mercury thermometer with a scale of (0-100)° C was used to measure the air and water temperature in the study stations. The air temperature was measured in the shade, while the water temperature was measured by immersing the thermometer under the surface of the water for a period of 5 minutes.

2.3.2. Electrical Conductivity

The measurement of electrical conductivity and salinity of the studied stations by using a field aperture type (WTWMULTi350) in units of millisiemens/cm for conductivity ppm for salinity.

2.3.3. Depth

Water depth was measured by using a long stick, and express the result in centimeters (cm).

2.3.4. Dissolved Oxygen

To measure dissolved oxygen used the Azide method with some modification of Winkler's method [27], and yield was expressed in mg/L units.

2.3.5. Reactive Nitrate

Reactive nitrate was estimated according to the method described in [27]. using a spectrophotometer at wavelengths of 220 and 275 nm.

2.3.6. Reactive Phosphate

Reactive phosphate was measured according by [27]. Adding 5 milliliters of the reagent consisting of (ammonium molybdate, ascorbic acid, and antimony potassium tartrate and then sulfuric acid to water and then filtered samples and left for 15 minutes until the appearance of blue color, and the absorbance was read by a spectrophotometer at 700 nm.

2.4. Quantitative Characteristic of Aquatic Plant Samples

2.4.1. Plant Biomass

The biomass of plants was estimated according to [28], collecting plant located inside a square (Quadrate) (1 m^2) by cutting it with a knife, then they were transported to the laboratory and dried by air, then the samples were weighed after drying them several times until the weight was stable.

2.4.2. Vegetation Plant Cover %

The percentage of vegetation plant cover for the type was calculated by the percentage of vegetation plant cover for one species to the number of squares studied according [29].

2.4.3. Frequency

The percentage of frequency was estimated (%).

2.4.4. Similarity

The similarity was calculated according [30] Jaccard as following:

$$J = a/(a+b+c)$$

J = evidence of similarity, a = the number of common species between the two stations, b = the number of plant species present in the first station and not present in the second station, c = the number of species present in the second station but not present in the first station.

2.5. Statistical Analysis

Statistical software was used SPSS (version 22) was used to find the statistical differences between the study stations and seasons and the correlation between the studied environmental factors.

3. Results

3.1. Water Temperature

The water temperature varied during the study period and for all stations, the highest temperature was 34.4°C recorded during the summer in Abu Sobat, while the lowest was 10.58°C recorded in the winter in Al-Burga station (Figure. 2). The results of the statistical analysis showed that there were significant differences ($p > 0.05$) in the water temperature between the seasons and the study stations, respectively.

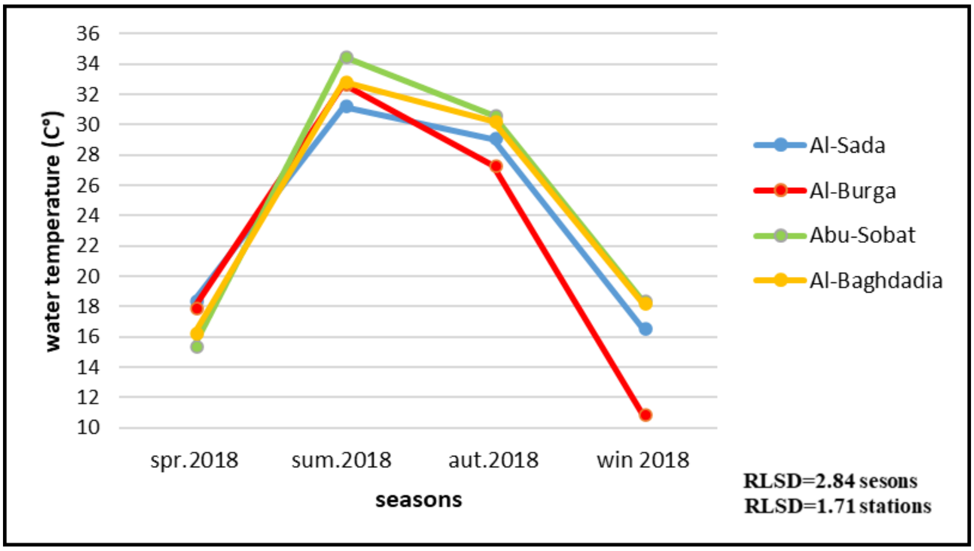

Figure 2. Seasonal changes in water temperatures for the study stations.

3.2. Electrical Conductivity

The highest value of electrical conductivity was 20.4 mS/cm recorded in the summer of 2018 in Al-Burga station, while the lowest value recorded 2.05 mS/cm recorded in the winter in Baghdadiya (Figure. 3). The results of the statistical analysis confirmed the existence of clear significant differences. $p<0.05$) between the stations of the study seasons.

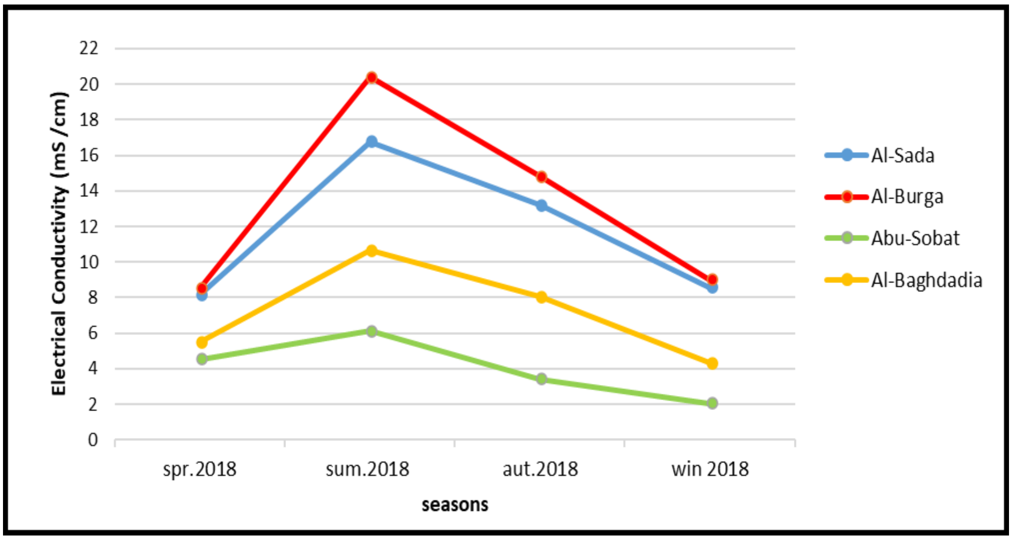

Figure 3. Seasonal changes in the electrical conductivity of the study stations.

3.3. Water Depth

The depth varied between 95-625 cm in eastern Al-Hammar, while they varied between 45-200 cm in Al-Chibayish. The lowest value was recorded in Al-Baghdadia during the summer and the highest in Al-Sada in the winter. The results of the statistical analysis showed that there were significant differences ($p<0.05$) between the seasons and study stations (Figure, 4).

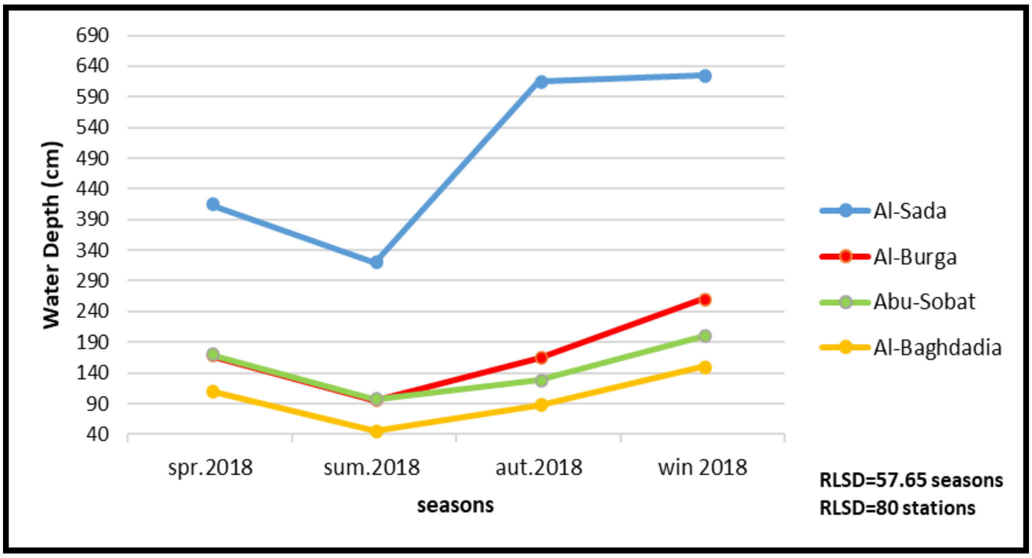

Figure 4. Seasonal changes in water depth for the study stations.

3.4. Dissolved Oxygen

The highest value of dissolved oxygen was 9.45 mg/L at Abu Sobat station in the spring, while the lowest values were 4.18 mg/L recorded during the summer at Al-Baghdadiastation (Figure. 5), and it was found that there were significant differences ($p<0.05$) between stations and seasons.

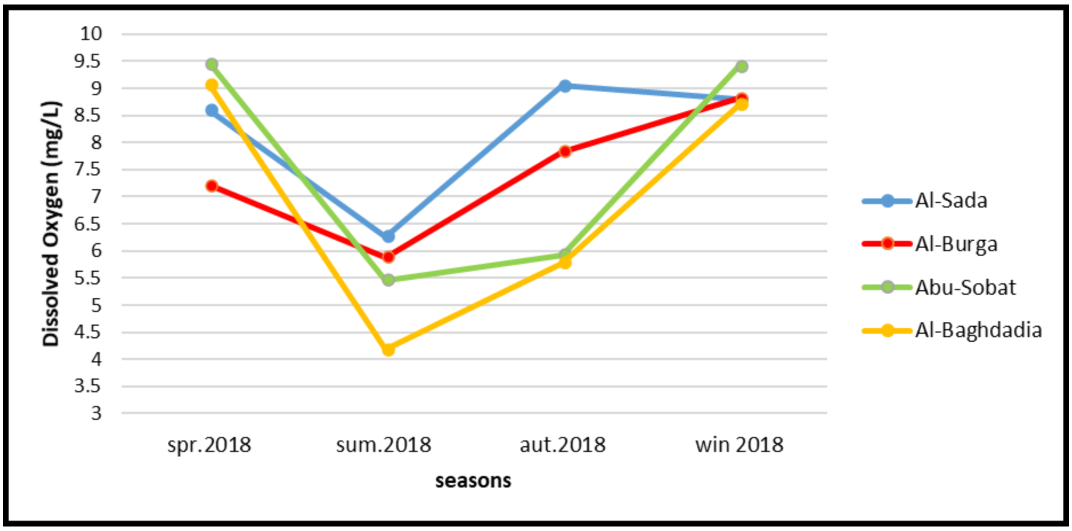

Figure 5. Seasonal changes in dissolved oxygen for the study stations.

3.5. Nitrate Measurement

The results of effective nitrates are shown in (Figure, 6). The nitrate values increased during the summer of 2018 for all stations, as the highest value reached 4.45 mg/L in Abu Sobat station, while the lowest value was 2.55 mg/L during the spring in Al-Baghdadia station. Statistical analysis indicated that there were significant differences. clear ($p<0.05$) between the stations and seasons.

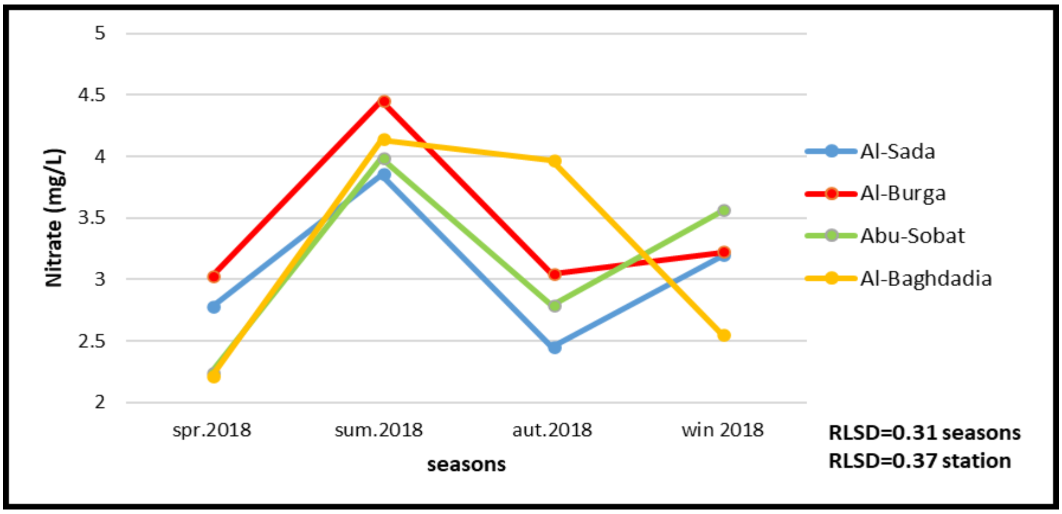

Figure 6. Seasonal changes in nitrates for the study stations.

3.6. Phosphorus Measurement

The highest value of active phosphate was 0.84 mg/L recorded during the summer at Al-Burga station, while the lowest value was recorded at Al-Baghdadia station during the spring 0.235 mg/L (Figure, 7). It was found from the statistical analysis that there are significant differences ($p<0.05$) between the values recorded for all stations.

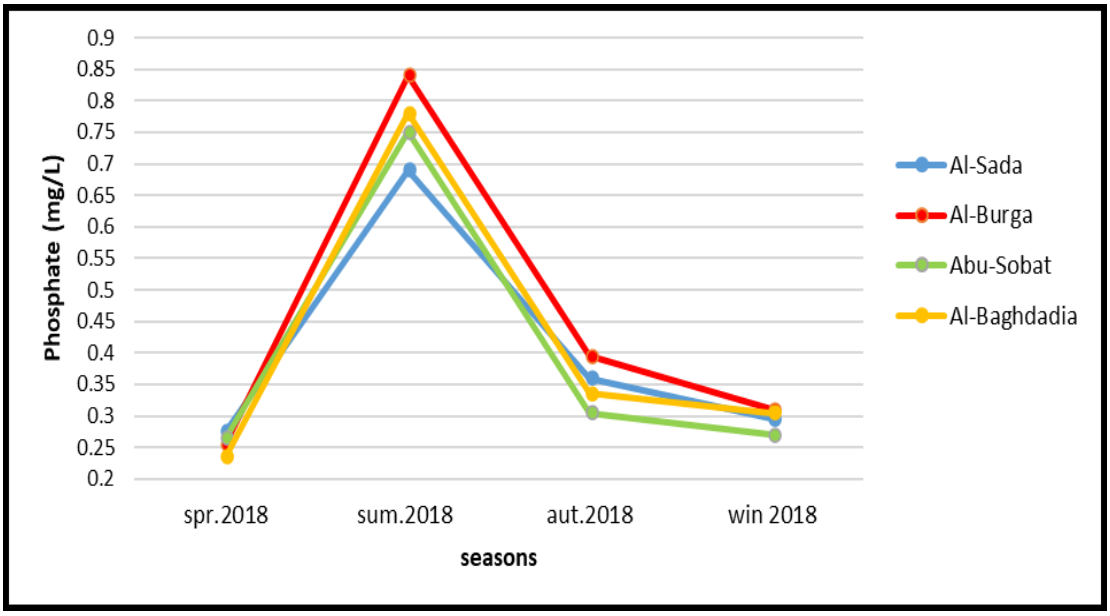

Figure 7. Seasonal changes in phosphate for the study stations.

3.7. Biomass

The results of biomass are shown in (Figure, 8). The plant species varied in the values of the biomass, and this variation was observed along the two study sites and seasons, the highest values were recorded *C. demersum* in the spring season in Al-Chebiyesh marsh, while the lowest values were 0 in *N. marina* in the eastern Al-Hammar during the spring and*M. spicatum*In the east Al-Hammar during the winter and the Al-Chebiyesh also during the summer, autumn and winter. The statistical analysis showed that there were significant differences ($p < 0.05$) between the values recorded for the two marshes during the study period and the seasons.

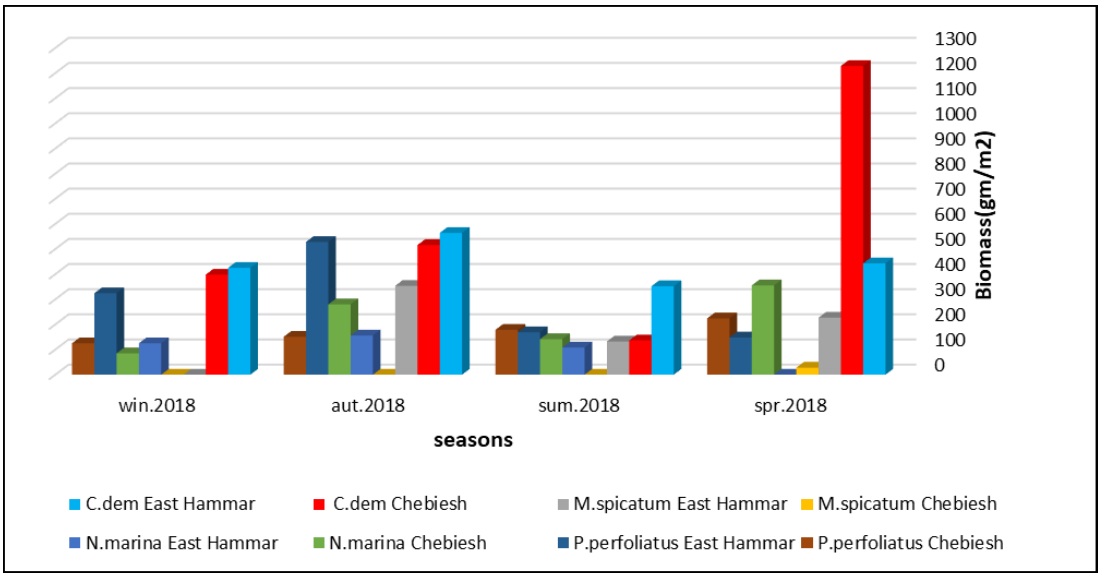

Figure 8. Seasonal changes in average plant biomass.

3.8. Vegetation Cover

The results are noted in (Figure, 9), the highest rate of vegetation coverage was recorded in *C. demersum* during the spring season in Al-Chibayish, when the coverage was zero for vegetation*N. marina*In the eastern Al-Hammar in the spring season and *M. spicatum*in the east Al-Hammar during the winter and the Al-Al-Chebiyesh during the winter, autumn and summer, and the results of the statistical analysis showed that there were significant differences ($p<0.05$) between the two marshes and the four seasons of the year.

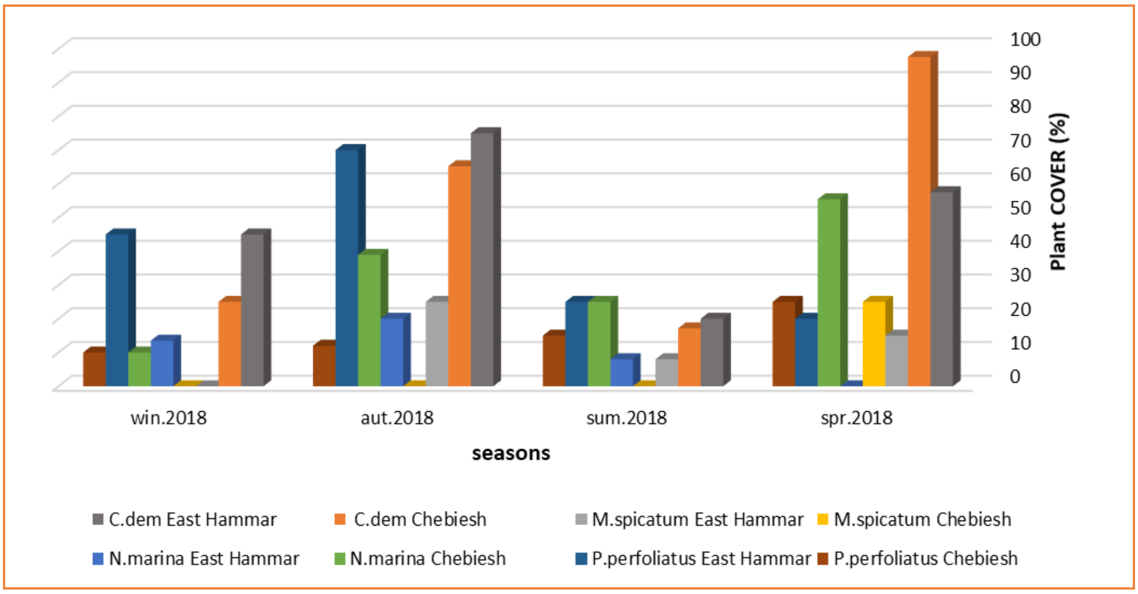

Figure 9. Seasonal changes in average vegetation cover in the marshes study.

3.9. Frequency

Figure (10) shows the seasonal changes in the average frequency of submersible plant species. The highest frequency was recorded *C. demersum* in spring is in Al-Chebiyesh marshes, while the lowest frequency is recorded in *N. marina*In the eastern Al-Hammar in the spring and *M. spicatum* in eastern Al-Hammar during the winter and in Al-Al-Chebiyesh during the summer, autumn and winter seasons, and the statistical analysis showed significant differences ($p<0.05$) between seasons and marshes of the study.

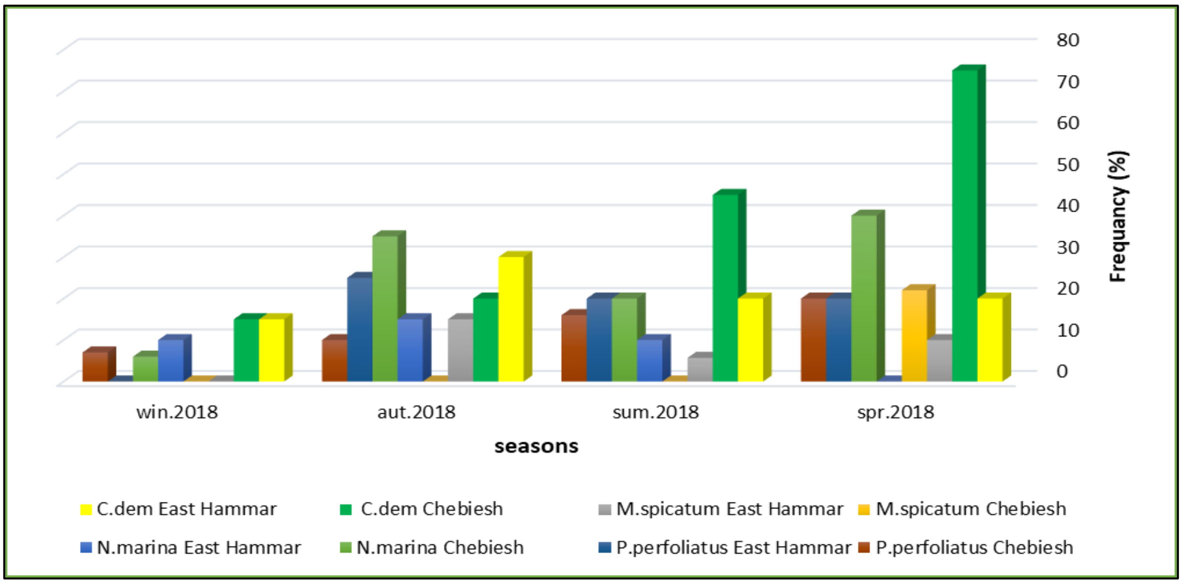

Figure 10. Seasonal changes in the rate of plant frequency.

3.10. Similarities

It is noted from Table (2) that the highest similarity rate of was recorded between Al-Sada and Abu-sobat stations 48.6%, and the lowest similarity rate was 15.6% between Al-Sada and Al-Baghdadia stations.

Table 2. Similarity percentages between the study stations.

Station	Al-Sada	Al-Burga	Abu-Sobat	Al-Baghdadia
AL-Sada	100			
AL-Burga	25	100		
Abu-sobat	48.6	28.6	100	
Al-Baghdadia	15.6	40	22.2	100

4. Discussion

Temperature is one of the environmental factors affecting the growth and activity of aquatic plants through its impact on the ecosystem, as the variation in temperature causes some changes in the qualitative composition of the plant assemblages. of aquatic plants and in different seasons. This was evident in the results of the current study. The recorded temperatures purified the water during the study period, clear seasonal and local changes, and it ranged between (8-10) C in the pond and (4-34) C in Abu Sobat, respectively, and this temperature It reflects the nature of the atmosphere prevailing in the region during the summer and winter seasons, which is known for its high temperature in summer and its extremes and lows in winter, reaching its lowest level. These results are consistent with many other studies [3,31,32,33].

Electrical conductivity is a measure of the dissolved salts in the water. The seasonal changes in the values of electrical conductivity were clear during the study period. The lowest values were recorded during the winter at Abu Sobat station. The reason may be due to the increase in water discharge as a result of rain and the lack of evaporation rates, which led to the dilution of water salinity and the reduction of water values. Salinity during the tidal process and the decrease in the water level in the Shatt al-Arab, and therefore the scarcity of water, its weak movement and its exposure to high evaporation, as well as the spread of marshes over large areas and the shallowness of the water column are all factors that lead to an increase in electrical conductivity values, and this is consistent with a study [18,34].

The depth of the water is one of the factors affecting the distribution of aquatic plants in general and submersible plants [35] and the results of this study showed the presence of seasonal changes in its measured values in the different study stations. The Chibayish Marsh of the fourth station

(Baghdadiya) because of the shallowness of the water column in the marshes, as well as the decrease in the Euphrates water supply feeding the central marshes, including the Chibayish, during the study period. The difference in the depth values recorded in previous studies was noted [18,32,34] With what was recorded in the current study for the same regions and according to the study period and circumstances.

Dissolved oxygen has a vital role in preserving aquatic life and is vulnerable to slight environmental changes. It is one of the important factors inferring water quality and organic pollution of the water body [36, 37]. In the current study, the highest value of dissolved oxygen was recorded and amounted to 9.45 mg/L during the spring season in Abu Sobat, as this station has running and continuous water in addition to the presence of aquatic plants in it, while the lowest values were 4.18 mg/L in Al-Baghdadia during the summer due to the high temperature water, which increases the rate of decomposition of organic matter and the speed of its consumption by organisms under these hot conditions, and therefore a negative and significant correlation of oxygen was found with the water temperature ($r = -0.642$, $p < 0.01$). Pathani (1995) indicated that the decomposition of organic matter at the bottom in the summer leads (in addition to the liberation of high amounts of carbon dioxide) to a high penetration of oxygen content as a result of the aerobic decomposition of organic pollutants, and the increase in sediment levels hinders the process of photosynthesis and thus decreases oxygen level, this agree with some previous studies [32,34,37,38].

Nitrate is one of the main nutrients in the aquatic environment, which represents the dominant form of inorganic nitrogen, and an increase in its concentrations in water leads to the phenomenon of eutrophication, as its values rarely exceed 10 mg / liter in natural water [28, 33]. The results of the statistical analysis showed significant differences in nitrate values between seasons and all locations. As the values recorded a significant increase during the summer season for all stations and were the highest in the pond due to its impact on the water coming from the Shatt al-Arab being the main feeder of the Hammar marsh, as the reason for the high nitrates in that station can be attributed to the decrease in river discharge of the Shatt al-Arab feeding the Hammar Marsh and the increase in the concentration of pollutants entering the river Directly or through the sub-channels associated with the Shatt Al-Arab, which receive large quantities of domestic, agricultural and industrial waste and wastewater that are rich in their content of nitrogenous compounds, and these compounds can undergo an oxidation process by microorganisms, and thus large quantities of nitrates are released into the water [38]. While the lowest concentrations were recorded during the spring season in Al-Baghdadia station, which is characterized by the abundance of aquatic plants that consume nutrients, including nitrates, as well as the lack of agricultural activity in it compared to its abundance in the lands adjacent to the Shatt Al-Arab that feeds the Hammar marsh. It was noted that there is a relative variation in the recorded nitrate values compared to previous studies [31,38,39].

Phosphate is present in water in various forms, including dissolved, suspended, and organic. Dissolved orthophosphate is one of the essential nutrients for phytoplankton, and an increase in its concentration leads to the phenomenon of eutrophication [40]. The population, agricultural and industrial uses, the properties of soil and rocks, and the sources of organic pollution, especially detergents, constitute the sources of phosphorus in the Iraqi water environment [41]. The results of the current study showed an increase in phosphate concentrations during the summer of 2018, the highest of which was recorded in the pond affected by the waters of the Shatt al-Arab feeding the Hammar Marsh, which may be attributed to the low level of river discharge and the increase in the concentration of pollutants entering the Shatt al-Arab directly or through sub-channels loaded with many phosphate-rich compounds. Such as washing powders, sewage water, and water for tapping agricultural lands fertilized with phosphate fertilizers [42]. The increase in phosphate concentrations coincided with the increase in salinity during the summer. High salinity values stimulate the release of phosphate from the sediment [43], as a significant positive correlation ($r = 0.68$; $p < 0.01$) was recorded between phosphate concentrations and electrical conductivity. While the concentrations decreased during the spring season for all stations, and the reason may be due to their consumption by aquatic plants and phytoplankton that are active during this season. Agricultural activity It was noted that the values recorded in the current study increased compared to previous studies [34,38,39].

The results of the statistical analysis showed a significant correlation between the live mass and the coverage of plant species and their recurrence.*C. demersum.* The highest values during the spring, as a result of its high ability to take in nutrients as well as its freedom of movement in the water, which allows it to expand to larger areas and produce more mass, as well as the shallowness of the water column in Al-Chebiyesh compared to the eastern Al-Hammar, which allows the arrival of high amounts of light that It increases the growth of submersible plants and their productivity, as lighting is an important factor affecting the composition and living mass of aquatic plants, while the lowest values were for *M.spicatum* in Al-Hawrain and *N.marina* in eastern Al-Hammar. This variation in biomass, coverage and frequency between submersible species is attributed to the fact that the distribution of biomass of submersible aquatic plants is affected by the characteristics of the bottom and lighting. For example, the presence of trees, prominent and floating plants, and algae reduces the light that reaches them, and thus the reduction of photosynthesis in them and a lack of live mass production [44]. Attention must also be given to several influencing factors that may cause the loss of live mass of the submersible plant at the beginning of its growth, such as grazing. by herbivores, or damage because of water movement or disease and death of the plant, which is also reflected in the frequency and coverage of the studied plants, and it was noted that the values currently recorded differed when compared with previous studies [32,34].
Similarity using the Jacquard index is one of the environmental indicators used to compare diversity between samples, which is commonly used by botanists to find out the effect of environmental variables on the forms and types of communities [45]. In the current study, the results showed that the highest qualitative similarity was recorded between the two stations of Al-Sada and Abu Sobat, and the reason may be attributed to the similarity of environmental variables between them, and the emergence of common species with high dominance in all stations did not prevent the emergence of differences in the similarity ratios between them, and since the selection of those was adopted to represent the differences in the quality of the environment, which is expected to affect the composition of species. This was shown by the least percentage of similarity between the two stations (Al-Sada) and (Al-Baghdadiya), which showed a discrepancy between them in terms of environmental factors, especially (salinity, nitrates, phosphates, depths, and the amount of light) [46].

Conclusions

The difference in biomass, coverage and frequency between submersible species is attributed to the fact that the distribution of biomass of submersible aquatic plants is affected by the biotic and abiotic factors, thus the reduction of photosynthesis in them and a lack of live mass production [44]. Several influencing factors may cause the loss of live mass of the submersible plant at the beginning of its growth, any change in environmental factors reflected on the frequency and coverage of the studied plants.
The percentage of similarity showed a discrepancy between them in terms of environmental factors, especially (salinity, nitrates, phosphates, depths, and the amount of light).

References

[1] Abbas, J. K. (2005) "Water quality monitoring of Abu Zirig marsh in southern in Iraq (after drying)" M.Sc. thesis Environmental Dept. College of Engineering. Al-Mustansiriya university.
[2] Hussien, N. A. (1994),"Ahwar of Iraq Environmental approach" Seas Researches Center, central of scientific seas 18: 149p.
[3] Dale, HM (1986). Temperature and light: the determining factor in maximum depth distribution of aquatic macrophytes on Ontario, Canada. J. Hydrobiology. 133:73-77.
[4] Barko, JW; Adams, MS and Clesceri, NL (1986). Environmental factors and their consideration in the management of submerged aquatic vegetation: A review, J. Aqua. Pl. Manage., 24: 1-10.
[5] Scheffer, M. (1998). Ecology of shallow lakes. Chapman and Hall, London, UK.
[6] Kantrud, H. (1990). Sago pondweed (Potamogeton pectinatus L.) A literature review. US fish and wildlife service, northern prairie wildlife research center, Jamestown, ND, USA: 89p.

[7] Olesen, B. and Madsen TV (2000). Growth and physiological acclimation to temperature and inorganic carbon availability by two submerged aquatic macrophyte species, Callitriche cophocarpa and Elodea canadensis. Funct. Ecol., 14:252–260.
[8] Pilon, J. and Santamaria, L. (2001). Seasonal acclimation in the photosynthetic and respiratory temperature responses of three submerged freshwater macrophyte species. New Phytol 151:659–670.
[9] Bornette, G. and Puijalon, S. (2011).Response of aquatic plants to abiotic factors: a review. Aqua. Sci., 73:1–14.
[10] Greulich, S. and Bornette, G. (1999). Competitive abilities and related rates in four aquatic plant species from an intermediately disturbed habitat. Freshw Biol 41:493–506.
[11] Lawson, E.O. (2011).Physico-chemical parameters and heavy metal contents of water from Mangrove Swamps of Lagos Lagoon , Lagos, Nigeria .Advan. Biol. Res., 5(1):08-21.
[12] Avvannavar, S.M. and Shrihari, S. (2007). Determination of water quality deterioration at Pilgrimage center along River Netravathi, Mangalore using WQI Approach. Environmental engineering and management Jou., 6(2): 123-131.
[13] Hicks, L.E. (1933). Ranges of pH tolerance of the Lemnaceae. Ohio State University. 296:237-244.
[14] Nurminen, L. (2003). Macrophyte species composition reflecting water quality changes in adjacent water bodies of Lake Hiidenvesi, Finland, Ann. Bot. Fenn. 40: 199-208.
[15] Onaindia, M.; Amezaga, I.; Garbisu, C. and García-Bikuña, B. (2005). Aquatic macrophytes as biological indicators of environmental conditions of rivers in north-eastern Spain.
[16] Wetzel, RG (2001). Limnological analysis. 3rd ed Springer-Vera lag New York Berlin Heidelberg SPIN Springer: 429pp.
[17] Durmishi, BH; Ismaili, M.; Shabani, A.; Jusufi, S.; Fejzuli, X.; Kostovska, M. and Abduli, S. (2008). The physical, physical-chemical and chemical parameters determination of river water Shkumbini (Pena) (partA). BALWOIS - Oherd, Republic of Macedonia: 27-31.
[18] Abawi, J.F.N. (2010).Salinity, dissolved oxygen, pH and surface water temperature condition in Nkoro River, Nigeria dalta .Adv. J. Food Sci. and Technol.,2(1):36-40.
[19] Zelnik, I.; Potisek, M.; and Gaberščik, A. (2012). Environmental conditions and macrophytes of Karst Ponds. Pol. J. Environment. Stud., 21. (6): 1911-1920.
[20] Christia, C.; Giordani, G. and Papastergiadou, E. (2018). Environmental variability and macrophyte assemblages in coastal lagoon types of Western Greece (Mediterranean Sea). Water, 10: P.151.
[21] Frankouich, TA; Gainer, EE; Zieman, JC and Wachnick, AH. (2006). Spatial and temporal distribution of epiphytic diatoms growing on Thalassi ctestudinum Banks ex Konigh relationship to waters quality, Hydrobiology 560: 259-271.
[22] Lougheed, VL; Crosbie, B. and Chow-Fraser P. (2001). Primary determinants of macrophyte community structure in marshes across the Great Lakes basin: latitude, land use, and water quality effects, Can. J. Fish. Aqua. Sci. 58: 1603-1612.
[23] Rosset, V.; Lehmann, A. and Oertli, B. (2010). Warmer and richer predicting the impact of climate warming on species richness in small temperate waterbodies, Globe. Change Biol. 16: 2376-2387.
[24] Cristofor, S.; Vadineanu, A.; Saˆrbu, A.; Postolache, C.; Dobre R. and Adamescu, M. (2003). Long-term changes of submerged macrophytes in the
[25] Bornette, G.; Amoros, C.; Castella, C. and Beffy, JL (1994a).Succession and fluctuation in the aquatic vegetation of two former Rhone river channels. Vegetatio, 110:171–184.
[26] APHA (American Public Health Association) (2005). Standard methods for examination of water and wastewater. 21th ed., Washington DC1193p.
[27] Lind, OT (1979). Hand book of common methods in limnology. 2nd. Ed. London: 109 pp.
[28] Khedr, A. and J. Lovett-Doust. (2000). Determinants of floristic diversity and vegetation composition on the Islands of lake Burollos, Egypt. Apple. Veg. Sci. 3(2): 147-156.
[29] Jaccard, P. (1908). Nouvelles researches sur la floral distribution. Bull. Soc. Vaudoie Sci. Nat., 44: 223-270.
[30] Republic of Iraq, Central Statistical Organization, Water Statistics, Unpublished Data,2021.
[31] Khalaf,R.Z.(2016) . Synecology of Macrobenthic Invertebrates of Three Different Aquatic Habitat at Southern Iraq .Ph.D.Thesis, collage of science , university of Basrah .Iraq.
[32] Al-Zaidi,S.A.A.(2017). Assessment of the Status of Submerged Aquatic Plants in Some Areas of East Hammar Marsh and Shatt Al-Arab River Southern Iraq Using Some Biodiversity Indices. MS.c.Thesis, collage of science , university of Basrah .Iraq.
[33] Al-Atbee,R.S.(2018). Assessment Of Some Heavy Elements and Hydrocarbons in the Water, Sediments and Dominant Aquatic Plants at Al-Chibayish marshes. MS.c.Thesis, collage of science , university of Basrah .Iraq.

[34] Al-asadi,W.M.(2014).Study of some environmental variables on the abundance and distribution of submerged aquatic plants Al-Hammar marsh and shatt AL-Arab,basrah journal of science .32(1):20-42.
[35] Serag, MS and Khedr, AA (2001). Vegetation-environment relationships along El-Salam Canal, Egypt. Journal of Environmental Metrics, 12: 219-232.
[36] Wetzel, RG and Likens, GE (2006). Limnological analysis. 3rd ed. Springer-Verlag, New York: 391 pp.
[37] USEPA (United States Environmental Protection Agency) (2001). Ground water and drinking water: List of drinking water contaminants and MCLs.
[38] Lomoljo, R.M.; Ismail, A. and ap, C.K.Y. (2009). Nitrate, Ammonia and Phosphate Concentrations in the Surface Water of Kuala Gula Bird Sanctuary, West Coast of Peninsular Malaysia. Pertanika J. Trop. Agric. Sci. 32(1): 1 – 5.
[39] Al Saadi, S.A.M. (2009). Taxonomic and ecological study of the wetland plants of southern Iraq, Ph.D. thesis, College of Science, University of Basrah, Iraq: 583 (in Arabic).
[40] Sharpley, AN; Daniel, T.; Sims, T.; Lemonyon, J.; Stevens, R. and Parry, R. (2003). Agricultural phosphorus and eutrophication. 2nd ed. US
[41] Hussein, N.A.; Al Najjar, H.H.; Al-Saad, H.T.; Youssef, O.H. & Al-sabonji, A. (1991). Shatt al Arab, basic scientific studies, marine Science center -Basra University Basra.
[42] Hussein, S.A. (2001). Sources of organic pollution in the interior Iraqi's water and the possibility of control and reuse', Mesopotamia of Oceanography, 16 (1: pp. 489-505.
[43] Clavero, V.; Fernandes, JA and Niell, FX (1990). Influence of salinity on the concentration and rate of interchange of dissolved phosphate between water in Fuente Piedra lagoon. (S. Spain) Hydrobiol., 197: 91-97.
[44] Madsen, JD; Stewart, RM; Way, A. and Owens, C.S. (2004). Distribution of Hydrilla (Hydrilla verticillata) and native submersed macrophytes in Lake Gaston, North Carolina and Virginia. Proc. Southern Weed Sci. Soc. 57: 313-316.
[45] Stilling, P. (1999). Ecology: theories and applications. 3rd ed. 638 pp.
[46] Rader, RB; Batzer, DP and Wissinger, SA (2002). Bioassessment and management of North American freshwater wetland. John Wiely and Sons, Inc.: 469 pp.