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Evaluation of Some Physical and Chemical Properties of Saffia Nature Reserve, Iraqi southern marshes

Omar Abdul-Ameer AL-Badran[1], Dunya Ali Al-Abbawy[2], Aiman Abdul-Latef Kowais[3]

[1,2] Department of Ecology, College of Science, University of Basrah, Basrah- Iraq

[3] Marine Science center, University of Basrah, Basrah- Iraq

E-mail: omar.a.kahtan@gmail.com

ABSTRACT

The present study was conducted during four seasons in nine stations representing the Saffia Nature Reserve, an area 44 km^2 Al-Hawizeh marsh, southern Iraq. Physical and chemical parameters were measured, including water temperature (WT), (pH), electrical conductivity (EC), dissolved oxygen (DO) in addition to levels of nutrients from September 2019 to August 2020. To assess the environmental impact on nature reserve could resist ecological disturbances; some results showed that the water quality standards in the Al-Hawizeh marsh are all within the standard parameters for freshwater habitats. Statistically, the analysis showed significant differences between seasons and stations. In general, all parameters are within the tolerance limits of freshwater plants and animals except for electrical conductivity (EC) and dissolved oxygen (DO), which need to be monitored seasonally and spatially, as differences between different stations in the nature reserve are observed in different seasons. Some recorded levels exceeded normal levels favorable for freshwater aquatic organisms. The marshes' waters are rich in nutrients, especially nitrates and phosphates, similarly reflecting high productivity to other Iraqi marshes. This is what we did not find in the current study. The obtained results were compared in the area with other studies. The recent survey could serve as a basis for additional monitoring and restoration of the marshland ecosystem.

Key Words: Natural Reserve, Al-Hawizeh marsh, Water Quality, Nutrients

Introduction

With increasing population growth and economic development, there has been a disappearance and degradation of wetlands worldwide (Davidson, 2014; Dixon *et al*., 2016). Therefore, wetlands can be considered an indispensable resource for humans.

The Mesopotamian Marshlands are among the most massive wetland bodies in the Middle East and Western Europe (UNEP 2001, Nicholson and Clark 2003; Hussain and Ali 2012), as they occupied a large area in southern Iraq. The marshes of southern Iraq are considered Aden's gardens on Earth due to their distinctiveness with many unique

characteristics. Mesopotamia is also known as one of the world's largest natural reserves, rich in birds and fish, as there are reed and sedge plants. Those plants are considered among the most critical areas for birds, their livelihood, shelter, and migration from various world regions (Kowais, 2005).

As a unique home to many endangered plants and animals, wetlands are considered the Earth's kidney, one of the most productive ecosystems in the world, and provide a variety of functions, including water purification, climate regulation, biodiversity conservation, and carbon sequestration (Costanza, 1997; Jordan *et al*., 2011; Carey *et al*., 2011; Chen and Lin, 2013; Chen *et al*., 2019). The marshes in Mesopotamia consist of three large complexes of wetlands in southwestern Asia, which include three main areas in the north, Al-Hawizeh Marsh, in the center, the central marshes (Al-Chibayish), and the south Al-Hammar Marshlands, and that all these areas are rich in natural resources and biological diversity (Maltby, 1994; Evans, 2002).

Natural reserves play a vital role in preserving the environment from the deterioration and decline of biological diversity .There are four main directions to protect biological diversity, which are the protection of habitats or natural habitats of living creatures, conservation of some species from overexploitation, the establishment of banks of threatened species and genes, and finally, reduction of pollution in the biosphere, as international and regional agreements have worked to implement these four directions to preserve biological diversity.

On the other hand, nature reserves are considered natural centers for researchers and postgraduate students. The existing living organisms are exploited to conduct scientific and medical research and space for scientific experiments (Al-Lawzi, 2007).

The monitoring water quality and sediments of the Saffia Nature Reserve (SNR) in the Hawizeh Marsh in southern Iraq after draining and its impact on the environmental reality. Hassan *et al*. (2011) studied some of the water and sediments' chemical properties and changes resulting from flooding and drying in the marshes. This shows the wide variation in the characteristics of water and sediments between immersion and drought stages.

Al-Abbawy *et al.* (2011) showed that this reserve is one of the wetlands restored from southern Iraq's marshes - Basrah suffers from rapid changes in the physical and chemical water properties as the study was extended monthly from December 2008 to November 2009. The study assessed the disturbances resulting from water loss affecting the quality of water, soil, and local communities of submerged aquatic plants.

The study site was classified into two stations depending on the water sources entering the reserve found that the water loss in the fund led to a reduction in the abundance and diversity of the immersed vegetation cover rate at (14%), (8%), and (10.6%), respectively. Sharply, the study concluded that the reserve is exposed to the destruction of plant communities and the occurrence of desertification unless there is a government role in returning water to it once other.

Study area

Al-Hawizeh Marsh is currently located within the southeastern part of the alluvial plain, precisely before the Tigris River meets the Euphrates River at Al-Qurna, and administratively it follows the northern part of the marsh to Maysan Governorate. In contrast, the southern part follows the Basrah Governorate. The total area of the marsh in the flood season is more than (3500 km^2), and this area decreases to (650 km^2) during the Drought season, and the site of the marsh on the Iraqi side is up to (2350 km^2). About (1900 km^2) were re-flooded after 2003. The capacity of the marsh is (5896) million cubic meters, with a surface area of (1800 km^2) for a level of (7) meters above sea level.

SNR is one of the largest reserves in Iraq and is located in (E: 47o 40.413 ', N: 31o 10.887'), located within Al-Saffia marsh, east of Al-Dasim marsh, is rectangular with an area of 44 km^2, length 11 km^2, and width 4 km^2. A dam parallel to the border strip with the Iranian side and the west is a dam parallel to the border barrier, and it is connected with the Ajirda dam. SNR is one of the types of

wetlands. It was established in 2006 by the Directorate of Agriculture in Basra Governorate to preserve biodiversity. Others, such as insects, crustaceans, and fish, especially during periods of migration, mating, and spawning (UNEP, 2001).

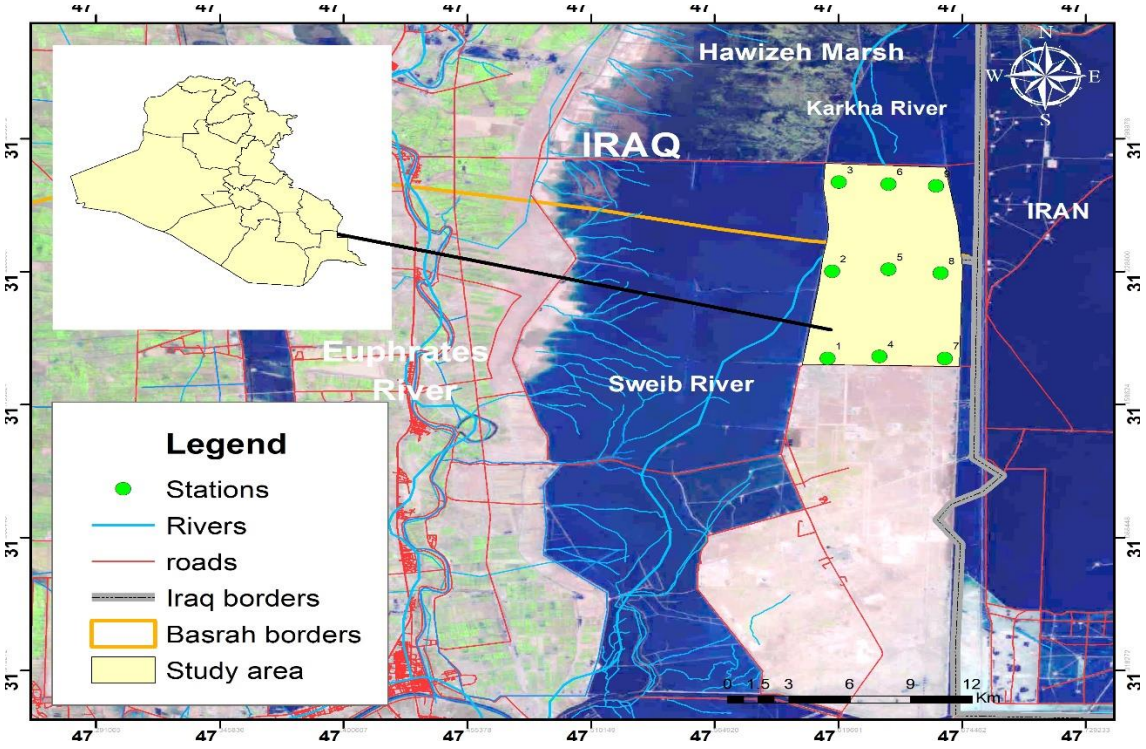


Fig 1: Map of study area

Figure 2: Photograph of study area

Materials and methods

Water samples were collected from September 2019 to August 2020 from nine different stations in Saffia Nature Reserve in Al-Hawizeh Marsh, as shown in Figs. (1) and (2).

The environmental Variables, which were measured in the field, A simple thermometer with a range of measured

parameters like water temperature. From (10-100˚C) graduate at 0.2˚C, (pH) and Electrical Conductivity (EC) (microsomes/cm) was measured by A Multiprobe type HANNA multimeter after calibrating the device before going to fieldwork with Buffer solutions,4, 7 and 9, Use the Milwaukee device to make the measurements of (DO) dissolved oxygen (mg/L). Water samples were collected from the field for the determination of NO3 and PO4 in the laboratory. Active nitrite NO_3 was measured according to (APHA, 2005), and active phosphate PO_4 was adopted in measure to (Strickland and Parsons, 1972).

Data were statistically analyzed using the analysis of variance (ANOVA). Data were collected statistically using Minitab ver.19, below the probability level of (0.05).

Results and Discussions

Physical and Chemical Parameters

Water Temperature (WT.)

Water temperatures are an important factor in all aquatic environments, as they directly affect organisms' chemical and biological processes (Mouillote *et al*., 2005; Simon *et al*., 2011). The ideal temperature range leads to better growth of living organisms, and this growth is affected by degrees; the temperature is either below or above the optimum range (Al-Hejuje, 2014). The results of water temperatures in the current study (Fig. 3) showed that the highest water temperature was (30.9 C^o) in Station No.9 during the summer season, while the temperature decreased to its lowest levels in the winter season when it was (13.4^o C) in Station No.3. Statistical analysis showed significant differences between seasons at a probability level ($P<0.05$), and no significant differences were observed between stations at a probability level ($P<0.05$).

This variation is due to the nature of the Iraqi climate in general, as thermal extremes characterize it, so it is hot and dry in the summer and cold and rainy in the winter (Al-Atbee,2018) maybe to the intensity of solar radiation throughout the hours of the day, especially in the summer (Salim, 2013), no slight differences or differences were recorded between the water temperatures on the surface and the lower layers inside the water column due to the shallow water in the Marshes. This variation in water temperature helps in the abundance and growth of different species of organisms in the area (Douaible *et al*., 2013) The local changes in water temperature may be due to the difference in the time of sampling, where the temperature is low in the early morning and then starts to rise as we approach the middle of the day (Moael, 2010) showed in (Fig. 4).

In general, the waters of the marshes in southern Iraq are characterized by the difference in temperatures during the seasons of the year, and this corresponds to the study of Al-Thahaibawi *et al*., (2014) where it was found that the water temperature in the southern marshes ranged between (14.3 C^o) and (35.6 C$^\circ$) In winter and summer respectively, and the study Mohammed *et al*., (2014) in Al-Hammar marsh in southern Iraq, where the temperature ranged from (15 C^o) in February to (31 C^o) in August.

Potential Hydrogen Ions (pH)

The pH value is one of the important measurements that determine water bodies' suitability for different purposes. It also plays a vital role in rivers. (Yousry *et al*., 2009), Most water organisms possess a specific range of pH and are highly sensitive to their changes (Al-Hassani *et al.*, 2014). The pH values recorded in the present study were within a narrow range. They tended to be alkaline as it is common in Iraqi inland water due to Iraqi natural waters' buffering capacity; with it is a relatively high content of calcium bicarbonate (Salman, 2006).

The results of the current study showed in (Fig. 3), as the lowest pH values in the study area reached (7.8) in No.2 and No.6 during the summer season, while the highest reached (8.7) in station No.5 during the winter season. The statistical analysis showed that there were significant differences between the seasons at the probability level ($P<0.05$), as well as the presence of significant differences between the stations at the probability level ($P<0.05$) showed in (Fig. 4).

It was observed in the present study that alkalinity is the predominant characteristic of the water in the stations. These results are in agreement with the pH of freshwater in different regions of the world (Baudo and Beltrami, 2001), as well as, with previous local studies on internal Iraqi waters (Hinton and Maulood, 1980), that the alkaline characteristic of Iraqi waters is mainly due to the nature of lime sediments of the marsh, so the lower pH values may be due to the nature of acid or the increase in the concentration of dissolved carbon dioxide as a result of the organic decomposition of the materials (Van Dolah *et al*., 2002) while Bora and Goswami (2015) indicated that the pH value of rivers depends on several factors, including local geology, the environment, as well as human influences. Also, the runoff of alkaline substances due to heavy rains is one of the factors affecting the high pH value of water (Al-Haidarey, 2002; Rubio-Arias *et al*., 2013). Higher temperatures lead to an increase in evaporation rates, which leads to an increase in the concentration of dissolved salts in water, which raised the pH value in the base direction (Odjadjare and Okoh, 2010).

In general, the waters of the Iraqi marshes are characterized by a low pH value in summer and high in winter, and this agrees with Mohammed (2010); Al-Kenzawi *et al.*, (2011); Al-Saboonchi *et al*. (2011); Douabul *et al*., (2013); Rikabi and Al Kubaisi (2014); Al-Abbawy and Al-Zaidi, (2018); Al-Thahaibawi (2019).

The current study of the pH values at Station No.5 during the winter season recorded a value higher than the permissible limits according to the World Health Organization (WHO, 2018), which is (6.5 - 8.5).

Electrical Conductivity (EC)

Electrical conductivity (EC) is defined as a measure of the ability of an aqueous solution to carry an electric current, depending on ions present, their equivalence, their total concentration, and their movement, as well as on the temperature at the time of measurement. The highest value of electrical conductivity was reached in the current study (7.1 mS/cm) in station No.2 in the spring. The lowest value was (3.44 mS/cm) in station No.5 in the autumn season (Fig.3). The statistical analysis showed that there were significant differences between the seasons at the probability level ($P<0.05$), and it was noticed that there were no significant differences between the stations at the probability level ($P<0.05$) showed in (Fig. 4).

The reason for the seasonal and monthly differences in the electrical conductivity values is attributed to the fact that it is associated with a decrease in water levels and an increase in the rate of evaporation in the summer, which leads to the dissolved ions being more concentrated and this leads to an increase in the electrical conductivity values in the water (Adamus *et al*., 2001; Al-Kinzawi *et al*., 2011), and the reason for the low values of electrical conductivity in the marshes water may be due to the dilution of salts by precipitation (Al-saad *et al*., 2010). The electrical conductivity value is also clearly related to the total soluble solids, as it reflects the water content of salts, nutrients, and organic materials (Parmar and Parmar., 2010). It is well known that the Iraqi marshes

were exposed to years of drought, which led to an increase in the concentration of salts in the sediments (Al-Abbawy, 2009; USAID, 2004).

The electrical conductivity values in this study exceeded the limits permitted by the World Health Organization (WHO, 2018), which is (2.5 mS/cm).

Dissolved Oxygen (DO.)

Dissolved oxygen in water is the first evidence to prove the purity of natural water since most aquatic organisms depend on the presence of dissolved oxygen to survive (Singanan *et al*., 2008). Therefore, dissolved oxygen is one of the most critical factors that affect the quality and degree of water bodies of water pollution in it (Yang *et al*., 2007).

The results of dissolved oxygen in the current study (Fig.3) showed that the highest value of dissolved oxygen was (10.1 mg/l) in station No.8 during the winter season. The lowest value was recorded in the summer season (5.5 mg/l) in stations No.4 and 5, the statistical analysis showed the presence of significant differences between the seasons at the probability level ($P<0.05$), and no significant differences were observed between the stations at the probability level ($P<0.05$), noting that there is a significant correlation relationship. Negative between dissolved oxygen and temperature showed in (Fig. 4).

In general, the waters of the marshes in southern Iraq are characterized by the low value of dissolved oxygen concentrations during the summer and their rise during the winter season, and this agrees with Mohammed (2010); Al-Kinzawi *et al*. (2011); Al-Saboonchi *et al.* (2011); Al-Zuwar *et al.* (2012); Douaible *et al*. (2013); Rikabi and Al Kubaisi (2014); Asadi (2014); Al-Abbawy (2018); Al-Thahaibawi (2019).

The presence of dissolved oxygen in the aquatic environment is affected by many factors, including the amount of rain, water temperature, salinity, the decomposition of organic matter in the water, the presence of aquatic plants, and the presence of pollutants, from (4 mg/l) (Cameron *et al*., 2003).

Most of the study results were for dissolved oxygen concentrations in the waters of SNR above the permissible limits according to the World Health Organization (WHO, 2018), which is (6 mg/l.)

Nutrients

Active Nitrate (NO_3^-)

The nitrate ion is one of the inorganic nitrogen forms in water and nitrate and ammonia (WHO, 2011). It is also a significant nutrient that contributes to building the vital activities of most living organisms. The high nitrate value is due to the flow of nitrogen-rich floodwaters that bring in large quantities of contaminated wastewater (Pradeep *et al*., 2012).

The results of the current study showed that the nitrate concentration reached the highest value (8.04 mg/l) in station No.1 in the winter season and the lowest value was (0.53 mg/l) in station No.6 during the same season (Fig.3). As an average of the plant values during the seasons, the highest sufficient nitrate concentrations were in the winter and spring seasons, and the lowest values were in the summer and autumn seasons. The statistical analysis showed a significant difference between the seasons at the probability level ($p<0.05$). In contrast, no significant differences were found between the stations at the probability level ($p<0.05$) showed in (Fig. 4), noting that there is a significant negative correlation at the probability level ($P<0.05$) between Nitrate concentrations and water temperatures.

The reason for the high nitrate concentrations during the winter season may be to the rains, which in turn dissolve the organic compounds and nitrogen fertilizers on the banks of the rivers (Lomoljo *et al*.,

2009) as well as the low nitrate consumption by phytoplankton and aquatic plants (Twomey and Jhon, 2001; Al-Saadi *et al*., 2008) and it is observed on the site of the study in terms of its lack of natural plants in a striking way, as well as the increase in oxidation of nitrite to nitrate as a result of the decrease in water temperature, which increases the concentrations of dissolved oxygen (Hussein and Fahad, 2008).

On the other hand, in the summer season, nitrate concentrations decreased most of the study stations. It may be caused by an increase in temperature and a decrease in dissolved oxygen concentrations, which leads to the reduction of nitrates to nitrites (Al-Emara *et al*., 2001). This study is in agreement with previous studies on the marshes in southern Iraq in terms of high active nitrate concentrations in winter and spring seasons and low in summer and autumn seasons, and this is what Al-Saboonchi *et al*. (2011); Douabul *et al*. (2013); Rikabi and Al Kubaisi (2014); Al-Thahaibawi *et al.*, (2014). The results of the active nitrate concentrations in the current study did not exceed the World Health Organization (WHO, 2018), which is (50 mg/l).

Active Phosphate (PO_4^{3-})

Active Phosphorus is an essential component of the aquatic environment and is the only form used for self-feeding of living organisms (Al-Obaidi, 2006). Phosphorus is also a limiting factor for plant growth in freshwater systems and plays a major role in increasing nutrients (Varol *et al*., 2011), Phosphorus is essential for different living organisms, and its increase also leads to an overgrowth of microorganisms in large quantities, which effects on other aquatic organisms (APHA, 2005; Bakan *et al.*, 2010).

The results of the current study showed that the highest effective phosphate concentration was recorded at station No.9 in the spring season was (0.133 mg/l). The lowest value was recorded at station No.6 in the winter season was (0.005 mg/l). The study stations' values during the seasons show that the highest value of the effective phosphate concentration was in the summer and spring seasons, and the lowest concentrations were in the winter and autumn seasons (Fig.3). The statistical analysis showed a significant difference between the seasons at the probability level ($P<0.05$), as well as the presence of significant differences between the stations at the probability level ($P<0.05$), noting that there is a significant negative correlation at the probability level ($P<0.05$) between the active phosphate concentrations. And water temperatures, showed in (Fig. 4).

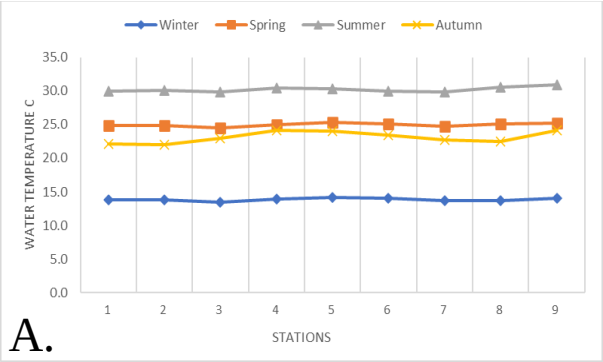
Conclusions

The following conclusions may be derived from the following Research:

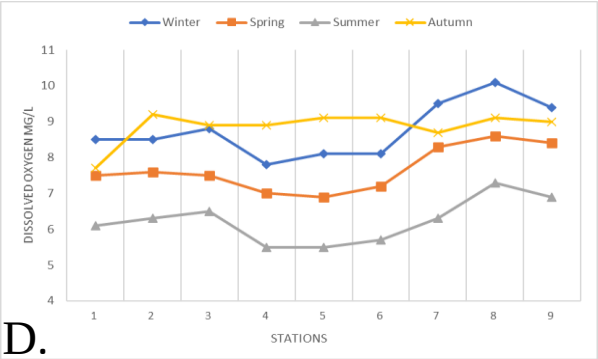
1- Through a comparison between the physical and chemical properties of water, it was found that its best properties were in the summer.
2- There is a negative exponential relationship between water temperatures on one hand and pH and dissolved oxygen on the other hand, and a positive relationship between water temperature and electrical conductivity.

The following recommendation may be derived from the following Research:

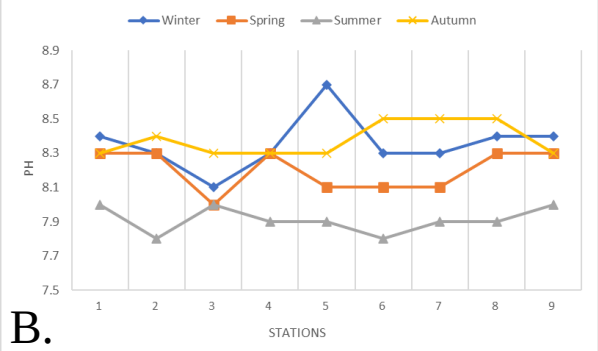
Continuous monitoring of the physical and chemical aspects of water provides valuable indicators of an ecosystem's overall health. However, short-term surveys of one year are not sufficient to judge whether the reserve appraisal process is achieving its goals. This survey showed that SNR was severely affected during the previous seasons, which negatively affected aquatic plants' presence, which ultimately led to their absence.



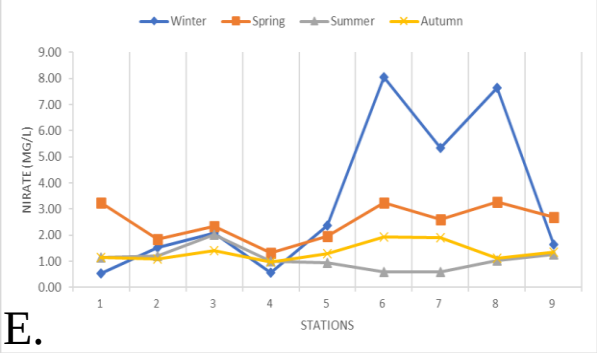
Water Temperature (WT.) C^{o}



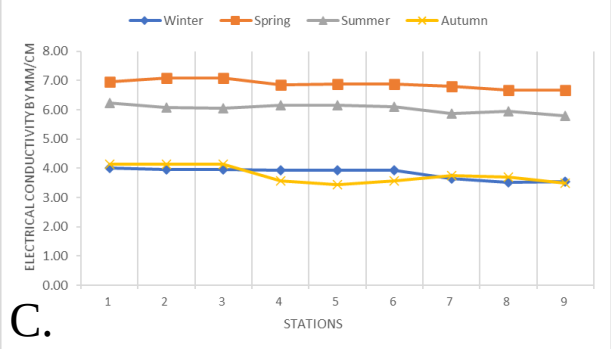
Dissolved Oxygen (DO.) Mg/l



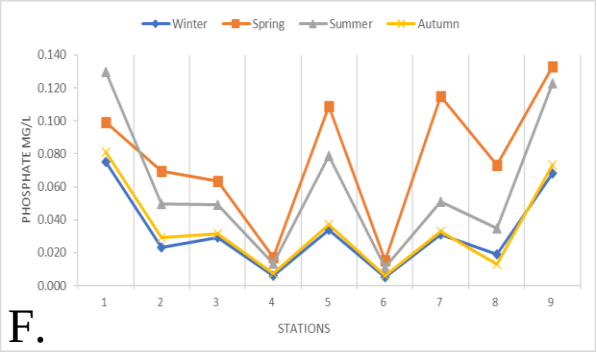
Hydrogen Ion Concentration (pH)



Nitrate Concentration (NO_3) Mg/l

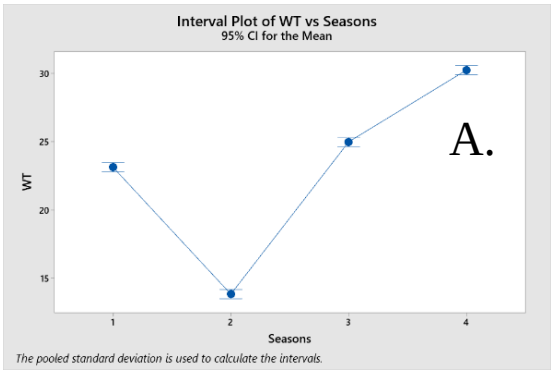


Electrical Conductivity (EC) µm/cm

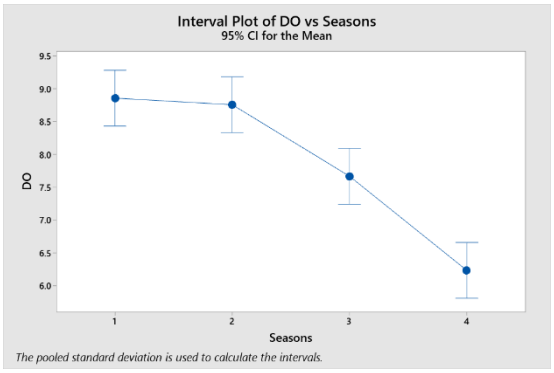


Phosphate Concentration (PO_4^{3-}) µg/l

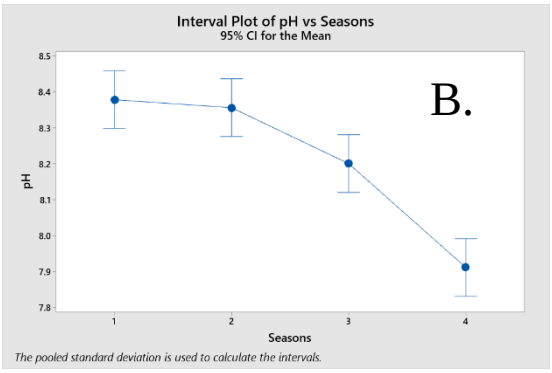
Figure 3. (A-F) Changes of water quality between Stations and Seasons in Saffia Nature Reserve during September 2019 to August 2020.



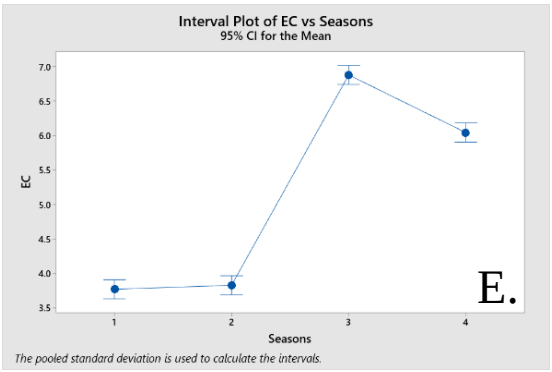
The rate of seasonally changes for Water Temperature (WT.) Co



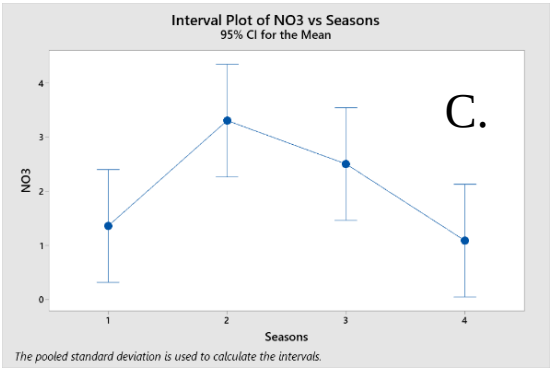
The rate of seasonally changes for Dissolved Oxygen (DO.) Mg/l



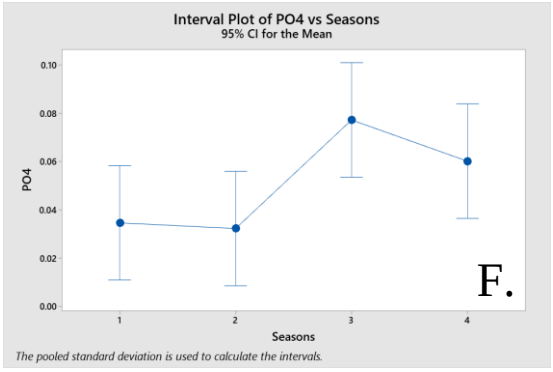
The rate of seasonally changes for Hydrogen Ion Concentration (pH)



The rate of seasonally changes for Electrical Conductivity (EC) µm/cm



The rate of seasonally changes for Nitrate Concentration (NO_3) Mg/



The rate of seasonally changes for Phosphate Concentration (Po_4^-) µg/l

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تقييم بعض الخواص الكيميائية والفيزيائية في محمية الصافية الطبيعية (SNR)، جنوبي العراق

عمر عبد الأمير البدران*، دنيا علي العباوي*، أيمن عبد اللطيف كويس
* قسم علم البيئة، كلية العلوم، جامعة البصرة، البصرة – العراق
مركز علوم البحار، جامعة البصرة، البصرة - العراق

المستخلص
تم إجراء هذا المسح خلال أربعة مواسم في تسع محطات تمثل محمية صافية الطبيعية الواقعة في هور الحويزة جنوبي العراق والتي تبلغ مساحتها 44 كم^2. تم تحديد بعض العوامل الفيزيائية والكيميائية، بما في ذلك معايير جودة المياه الطبيعية مثل درجة الحرارة (WT)، قيمة الأس الهيدروجيني (PH)، التوصيل الكهربائي (EC)، الأوكسجين المذاب (DO) بالإضافة إلى قياس بعض تراكيز العناصر الغذائية للفترة الممتدة من ايلول 2019 الى آب 2020. تم تقييم الأثر البيئي على هذه المياه وما إذا كانت المحميات الطبيعية لديها القدرة على مقاومة التغيرات والاضطرابات البيئية، وأظهرت النتائج أن بعض معايير جودة المياه في مستنقع الحويزة كانت ضمن المعايير القياسية لبيئات المياه العذبة. أظهرت نتائج التحليل الإحصائي وجود فروق معنوية بين المواسم والمحطات. بشكل عام، تكون جميع العوامل ضمن حدود تحمل نباتات وحيوانات المياه العذبة باستثناء التوصيل الكهربائي (EC) والأوكسجين المذاب (DO) التي تحتاج إلى رصد موسمياً ومكانياً، حيث لوحظت الاختلافات بين المحطات المختلفة في المحمية الطبيعية في بعض المواسم. تجاوزت بعض المستويات المسجلة المستويات العادية المواتية للكائنات المائية في المياه العذبة. إن مياه الأهوار غنية بالمواد المغذية وخاصة النترات والفوسفات مما يعكس إنتاجية عالية بشكل مشابه للأهوار العراقية الأخرى لكن هذا ما لم نجده في الدراسة الحالية. تمت مقارنة النتائج التي تم الحصول عليها في المنطقة مع دراسات أخرى. يمكن أن يكون المسح الحالي بمثابة أساس لمزيد من المراقبة واستعادة النظام البيئي للأهوار.

الكلمات المفتاحية: المحميات الطبيعية، هور الحويزة، نوعية المياه، المغذيات