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Temporal and Spatial Changes of Some Chemical Properties of Waters at the Northern Part of Shatt al-Arab

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Abstract: This study was conducted to determine some chemical properties of the water at the northern part of the Shatt al-Arab, and knowing the factors that affect the water quality at the study stations, dissolved oxygen and nitrate ion concentration has been studied in water. Water samples were taken from six stations (Al-Ezz, Mezaira, Al-Swaib, Al-Shafi, Karmat Ali and Sinbad). Samples were collected seasonally at 2018. The study showed an increase in DO values at stations of the northern part of the study area, at Mezaira, Al-Ezz, Al-Swaib and Al-Shafi stations. Low values of DO towards the south of the study area (Karmat Ali and Sinbad Island). All values were within the normal limits for WHO, 2006. DO values increased during the winter compared to the values of spring, summer, and autumn seasons. DO values increased in the middle of the river compared to the left and right banks. DO values for surface depth (d1) increased compared to depths d2, d3. The study showed that the NO_3 values decreased in stations of the northern part of the study area. It is noted that the values of the winter season increase compared to the values of the spring, summer and autumn seasons. Height of the right bank of values compared to the values of the middle of the river and the left bank. Values rise in d1 compared to the values of d2, d3, where there was no difference between them.

***Keywords*:** Temporal changes, Spatial Changes, Watr, Chemical properties, Shatt al-Arab

Shatt al-Arab is one of the important rivers in Iraq, which was formed as a result of the confluence of the Tigris and Euphrates rivers in Al-Qurna (70 km north of Basra), 205 km long, shares borders with Iran in the lower part (Hamdan 2009). Shatt Al-Arab is associated with internal sub rivers-which affect water quality (Al-Shawi and Al-Rubaie 2007). Dissolved oxygen is one of the most important properties of river water for estimation of, water quality. The microorganisms need oxygen for vital efficacy, to convert organic matter molecules into simple substances. In addition, fish need dissolved oxygen to sustain their lives. Lack of dissolved oxygen in water leads to anaerobic decomposition of pollutants into the water, leads to toxic gases such as methane and hydrogen sulfide. Many factors affect the level oxygen, such as discharge and movement of surface water, the difference in air pressure as well as the depth of the water, concentration of salts and organic matter in the water body (Rahman et al 2012). The concentration of dissolved oxygen in the natural waters necessary for the growth and reproduction of aquatic organisms must not exceed 5-25 mg l^{-1} and for drinking water should not exceed 5 mg l^{-1} (WHO 2006). Nitrates are present in rainwater with a concentration of 0.1-0.3 mg l^{-1} and groundwater 600 mg l^{-1}, whereas the nitrate concentration in surface water ranges from 0-18 mg l^{-1}.

This study aims to know the concentration of both dissolved oxygen in water (DO) and nitrate (NO_3) in the waters of the northern part of the Shatt al-Arab and the rivers feeding and branching from it, as well as in the terrestrial waters adjacent to these rivers.

MATERIAL AND METHODS

Samples were collected seasonally, at January, April, August and October represents winter, spring, summer and autumn respectively at 2018. DO was measured in the morning based on the Tide Time program by the Reverse Water Sampler. Water samples were taken for three locations from the river, namely the right bank (R), the middle of the river (M) and the left bank of the river (L), three depths of the water column, the surface layer (d1), the middle of the river's water depth (d2) and 1m from the bottom of the river (d3), with three replicates, placed in plastic bottles of size 2 to be washed with alcohol and distilled water. Dissolved oxygen in water was measured in field "by CRISON multi meter. The nitrate ion is estimated by the Spectrophotometer, along with a wavelength of 220 nm. The drainage of the Shatt al-Arab water was taken from the data of the Directorate of Water Resources, Basra for the year 2018 (Fig. 2). Weather forecast data for Basra Governorate were also taken from the General Authority for Meteorology and Seismic Monitoring, Baghdad. The data were analyzed statistically by the Genastat (Ver. 10.3.0) statistical program.

RESULTS AND DISCUSSION

There was a significant effect of the DO during the study period, at these stations (Figure 2). DO in Karmat Ali station are low (7.31 mg l^{-1}) due to human activities and population density on both sides of the river. The high DO of Mazira station (7.95 mg l^{-1}), indicates its distance from pollutant sources. DO in Al-Ezz, Al-Swaib Al-Shafi and Sindbad Island stations was 7.80, 7.83, 7.64 and 7.46 mg l^{-1}, respectively, according to the percentage of pollution in these stations from wastewater and household waste.

The high values are evident during the winter season (7.98 mg l^{-1}) (Table 2) may be rise is lower temperatures during this season (data of the General Authority for Meteorology and Seismic Monitoring- Baghdad 2018), contributes to more dissolution of oxygen in water (El Morhit and Mohir 2014), while a decrease in the value of DO was observed during the spring and summer seasons (7.94 and 6.99 mg l^{-1}), respectively, due to the high temperatures compared to winter, gives the possibility to increase the activity of microorganisms, increased oxygen demand for breathing and growth processes (Al-Lami et al 2001). the values increased during the autumn compared to the summer (7.76 mg l^{-1}), due to the relatively low temperatures during this season compared to the summer (Mays and Abdulameer 2011, Abdel-Razzaq et al 2015). The percentage increase in DO values during the winter, spring and autumn seasons compared to the summer 14.16, 13.59, and 11.01%, respectively.

The incidental water sampling site from the river had a highly significant effect on DO values (Table 2, Fig. 4). The maximum DO was in the middle of the river compared to the

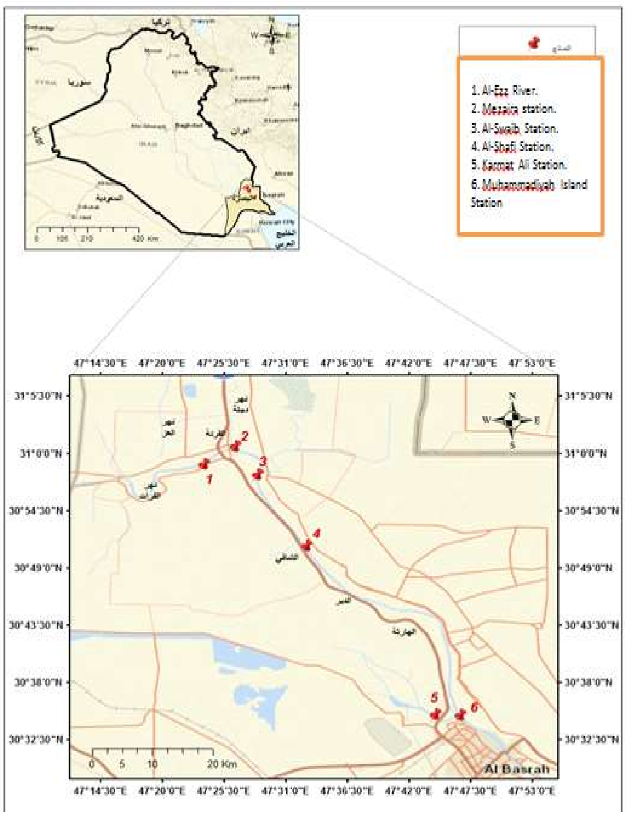

Fig. 1. Study area is drawn using the Arc GIS program-Eart

Table 2. Statistical analysis of DO and NO3 values for stations, seasons, locations and depths of samples take

Source	DO	NO_3
A	20389.56**	21760.3**
B	12092.23**	716.09**
C	113000**	16.17**
D	71854.64**	1687.45**
AB	1209.61**	17.83**
AC	5183.76**	1.19n.s
BC	1376.32**	1.52n.s
AD	461.91**	5520.06**
BD	133.57**	40.67**
CD	13420.63**	1.61n.s
ABC	835.02**	1.37n.s
ABD	213.44**	15.57**
ACD	1201.15**	2.38**
BCD	322.23**	1.82n.s
ABCD	258.13**	1.99**

Table 1. The coordinates of the study stations located in the northern part of the Shatt al-Arab

Stations	The coordinates		Notes
	E	N	
Al-Ezz	47° 23' 03.72"	30° 58' 47.90"	Effect of Al-Ezz River
Mezaira	47° 26' 29.87"	31° 00' 23.81"	Effect of Tigris (Comparison Station)
Al-Swaib	47° 28' 33.33"	30° 58' 30.10"	Effect of Al-Hawizeh marshes
Al-Shafi	47° 32' 31.79"	30° 31' 15.77"	Effect of Al-Hammar marshes
Karmat Ali	47° 43' 59.48"	30° 34' 54.56"	Effect of Al-Msahab and Al-Salal Rivers
Sinbad Island	47° 46' 29.24"	30° 34' 50.48"	Aggregate effect of previous stations

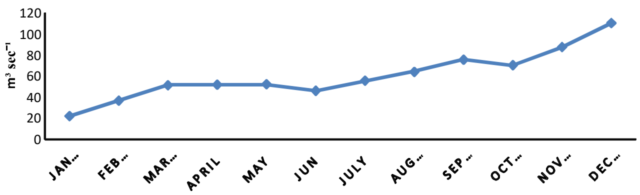

Fig. 2. Shatt al-Arab water drainage (m^3. Sec^{-1}) in Basrah city for the year 2018 (Water Resources Directorate, Basrah data)

left and right banks. This may be due to large movement of water currents in the middle of the river compared to both banks of the river, the greater the possibility of gas exchange in the middle of the river (Hamzah 2019). There was a highly significant effect on DO with average in the surface depth (d1 of 8.00 mg l^{-1}. This due to the possibility of gas exchange with atmospheric air and the dissolution of oxygen in water compared to other depths, as well as the consumption of oxygen in the depths by aquatic values for surface depth (d1) was 4.75 and 7.87%, respectively, Xia et al (2019) when study the Longang River in China show same trend.

As for the interaction between the station and season factors, a highly significant effect on the DO values (Table 2), Figure 6 shows high DO values in Shatt Al-Arab stations water during the winter season and with significant differences according to the low water temperatures during this season, which has an inverse relationship with the dissolution of oxygen in water (Antoine and Saad 1987, El Morhit and Mohir 2014, Abdel-Razzaq et al (2015) observed that during the spring the values decrease, notes the low values for all Shatt al-Arab stations during the summer (lowest values), due to the rise in water temperatures depending on the "rise in air temperature, the result of reducing the possibility of holding oxygen atoms when temperatures rise, the values begin to rise during the fall season (Mays and Abdulameer 2011). Decreased values in the stations water located south of the study area (Karmat Ali and Sinbad Island), the reason for this is due to the high salinity of the water in these two stations, which leads to a decrease in the values of dissolved oxygen in the water, the reason was attributed to the high salinity of the water of these two stations, which leads to a decrease in the solubility of gases in the water, or by the presence of an oil layer of water that is received from these two stations, which forms an insulating layer on the surface of the water that prevents gas exchange from the air, the reason is also due to the population density in these two stations and the sewage and wastewater that is dumped into the river water (Al-Khuza'i 2014).

The values were 7.57 and 7.70 mg l^{-1} respectively. The DO values increased during the winter season in the water of the stations located to the north of the study area (Al-Ezz, Mazria, Al-Swaib and Al-Shafi), reached the highest values in the water of the Mezaira stations, the reason is because this station is near the Tigris, as mixing water increases the possibility of dissolving oxygen in the water (Al-Lami et al 2001). The water values of these stations were 8.17, 8.50, 8.30, and 7.88 mg l^{-1}, respectively, the lowest value is in the water of Al Shafi Station, the reason for this is due to the human activities in this area, because the high population density and the consequent water from puncture and wastewater dumped into the river lead to a decrease in the values of DO (Falih and Rashid 2016). DO values decreased in the waters of Shatt El-Arab stations during the spring, due to the rise in water temperatures depending on "the rise in air temperature", the values in Al-Ezz, Mezaira, Al-Swaib, Al-Shafi, Karmat Ali and Sinbad Island stations reached 8.11, 8.48, 8.27, 7.81, 7.41 and 7.60 mg l^{-1}, respectively.

Figure 6 shows a decrease in DO values during the summer due to high temperatures and low oxygen solubility in water (El Morhit & Mohir 2014), the highest drop was at the Al-Swaib station due to the materials dumped in the river, increase the activity of microorganisms in nutrition on these materials, thus the increased breathing and oxygen consumption in the river water, the percentage of decrease in the water Al-Ezz, Mezaira, Al-Swaib, Al-Shafi, Karmat Ali and Sinbad Island stations water during this season compared to the winter 12.72, 16.35, 19.54, 19.40, 8.98 and 9.35%, respectively. DO values increased significantly in all study stations during the autumn season, due to lower temperatures compared to the summer (General Authority for Weather Forecast and Seismic Monitoring / Baghdad 2018 data), likewise, the high water discharge values as a result of a flood caused by the breaking of the earthworks in the Hawizeh marshes, which led to the mixing of water and an increase in the solubility of oxygen in the water (Al-Bahali and Sadkhan 2011). The percentage increase in the values during this season compared to the summer for Al-Ezz, Mezaira, Al-Swaib, Al-Shafi, Karmat Ali and Sinbad Island stations reached 9.39, 7.78, 14.50, 10.48, 7.11 and 8.59%, respectively, the percentage of increase in Karmat Ali and Sinbad Island stations is low because the location of these two stations is near Al Hartha and Najibiya power plants , contributes to raising the temperature of the water, which in turn reduces the dissolution of oxygen in the water, the organic materials that are dumped into the river water by feeding the microorganisms on those substances and depleting them of oxygen during the breathing process, as well as the impact of the salt tide from the Arabian Gulf during this chapter .

Statistical analysis of the F test (Table 2) shows that there is a highly significant effect on the DO values of the interference between the station operators and the sampling sites in the DO values, Figure 7 shows DO values increased significantly in the middle of the river and for all study stations, due to the movement of the water currents and the movement of the boats, as well as "the effect of the movement of the winds that are higher than they are on the left and right banks of the river (Hamzah 2019) , which leads to mixing water and increasing the melting of oxygen in the water.

The DO values in the left bank water for Al-Ezz, Mezaira, Al-Swaib, Al-Shafi, Karmat Ali and Sinbad Island stations were high compared to the right side, which indicates a high rate of pollution in the water of the right bank of these stations,

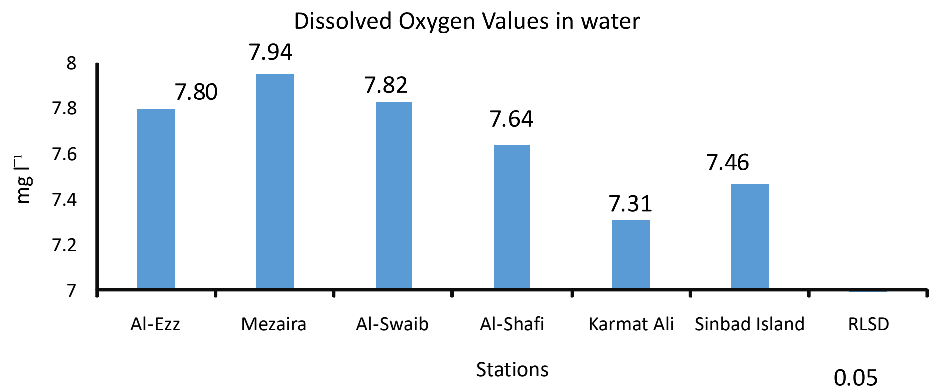

Fig. 2. Spatial heterogeneity of DO values (mg. l^{-1}) in Shatt Al-Arab

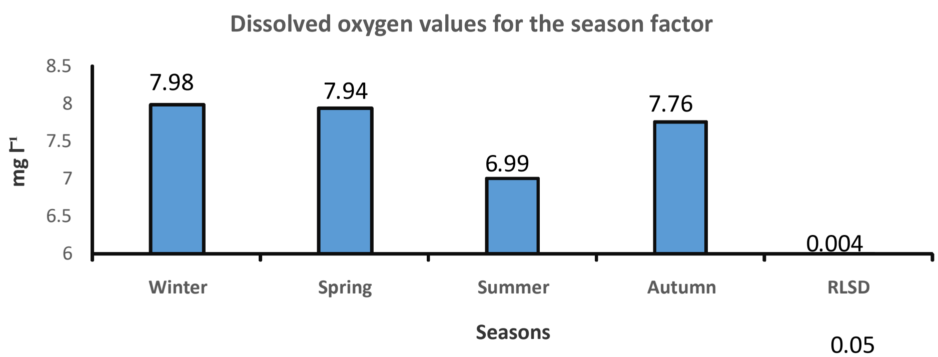

Fig. 3. Temporal variance of DO values (mg. l^{-1}) in Shatt Al-Arab

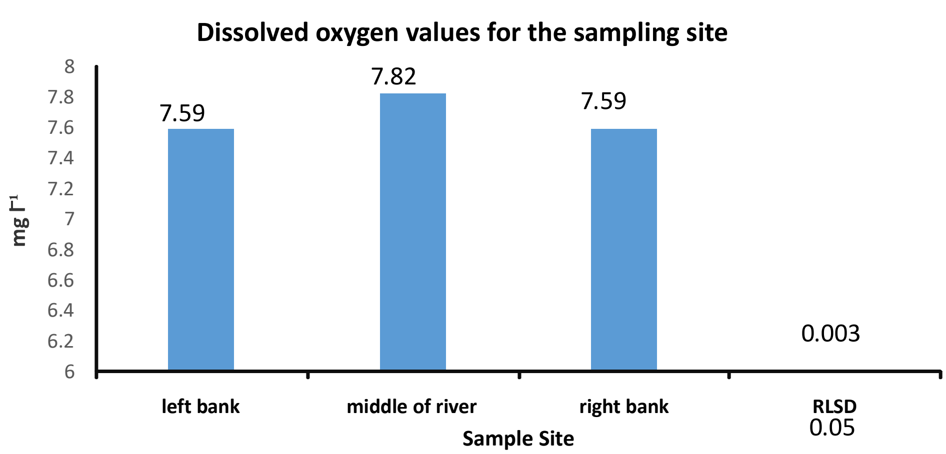

Fig. 4. DO values (mg. l^{-1}) for the cross-sectional sampling site

according to sources of pollution such as wastewater and household waste, causes the DO values to decrease through oxygen consumption by the microorganisms that feed on their organic matter, in addition to the presence of Al-Najibiyah Power plant on the right bank of Sinbad Island, being dumped with high temperature water into the river which leads to low oxygen solubility in water, the rise in DO values in the right bank waters from the Karmat Ali and Mezaira stations, indicates an increase in pollution in the water of the left bank, DO was a measure of river water quality (Boyd 2000).

There was a highly significant effect of the interaction between the stations and the depth of taking samples from the Shatt al-Arab (Figure 8), DO values rise in the surface depth of the river (d1) for the possibility of gas exchange at the surface depth of the water more than other depths (Xia et al 2019), for example, the percentage of low values of DO in water in the middle of the water column and near the river bed compared to the surface depth in the waters of the two plants of Mezaira (the highest values recorded) and Karmat Ali (the lowest values recorded) were 5.52, 8.28 and 3.29, 7.25%, respectively, the differences between the depths d2 and d1

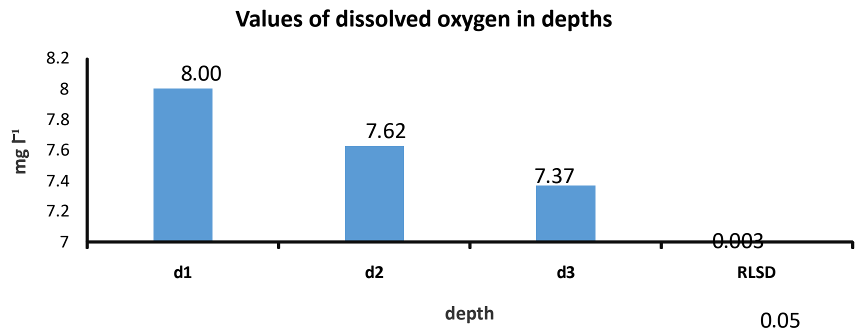

Fig. 5. DO values (mg. l^{-1}) for the cross-sectional sampling site

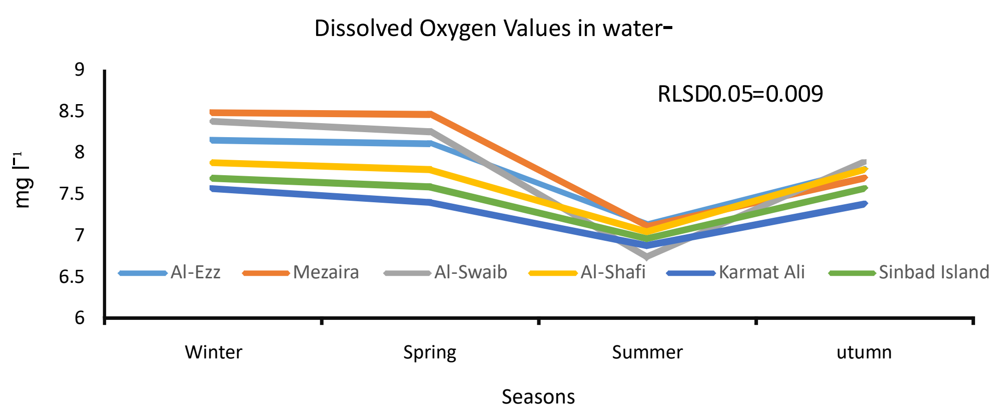

Fig. 6. DO values (mg. l^{-1}) for interaction between stations and seasons

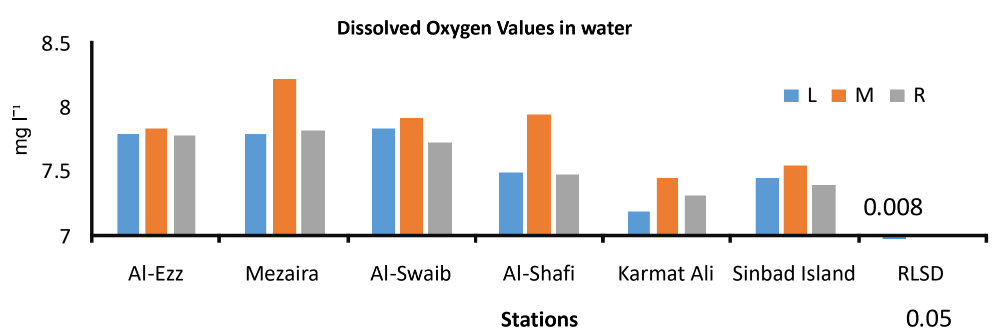

Fig. 7. DO values (mg l^{-1}) for interaction between stations and sampling sites

compared to d1 were few in Karmat Ali station, which indicates the penetration of pollutants to the depth of the river.

There was a highly significant effect of the interaction between stations and the locations and depths of modeling (Figure 9) high values of DO in the middle of the river for all study stations, The reason was the movement of winds and the movement of currents in the middle of the river are higher than the banks of the river, leads to an increase in gas exchange between the atmosphere and river water, for example, the percentage of height of DO values in waters in the middle of the river compared to the left and right banks in the Mazira plant was 7.31, 7.08%, which indicates the large number of pollutants in the left bank of the river, the values of the left bank in Sinbad Island station are high compared to the right bank, the percentage increase of DO values in the middle of the river width compared to the left and right bank 1.27, 0.38%, due to the water thrown from the Najibiyah

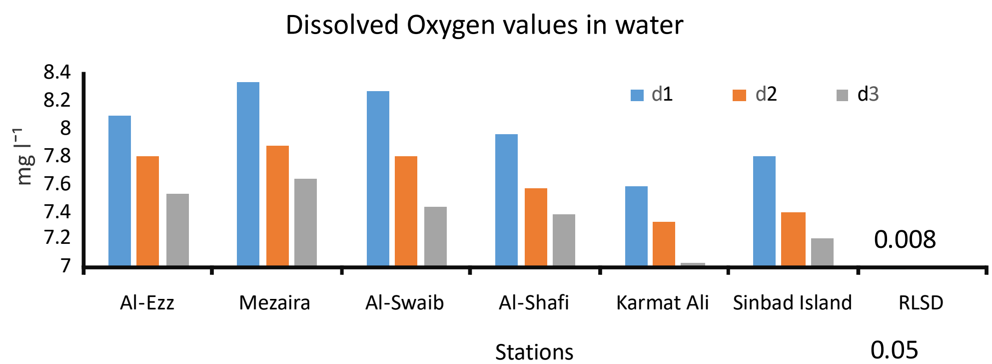

Fig. 8. DO values (mg. l^{-1}) for interaction between stations and depths of river sampling

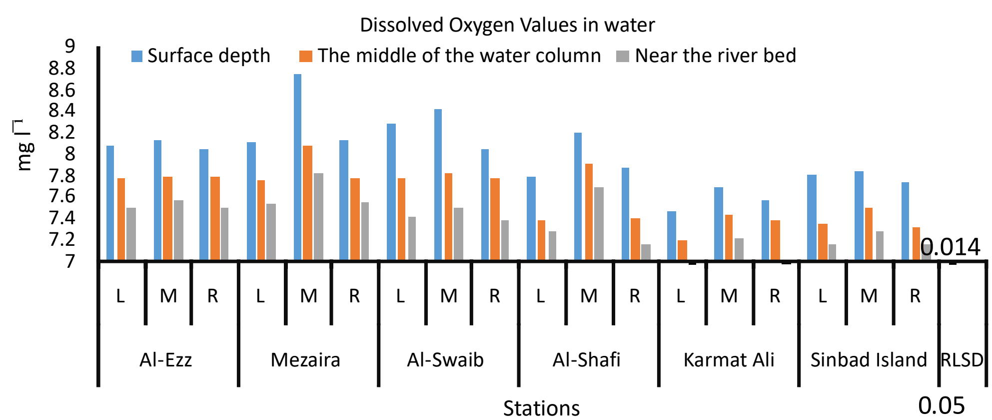

Fig. 9. DO values (mg. l^{-1}) for interaction between stations and depths of sample taking from the river

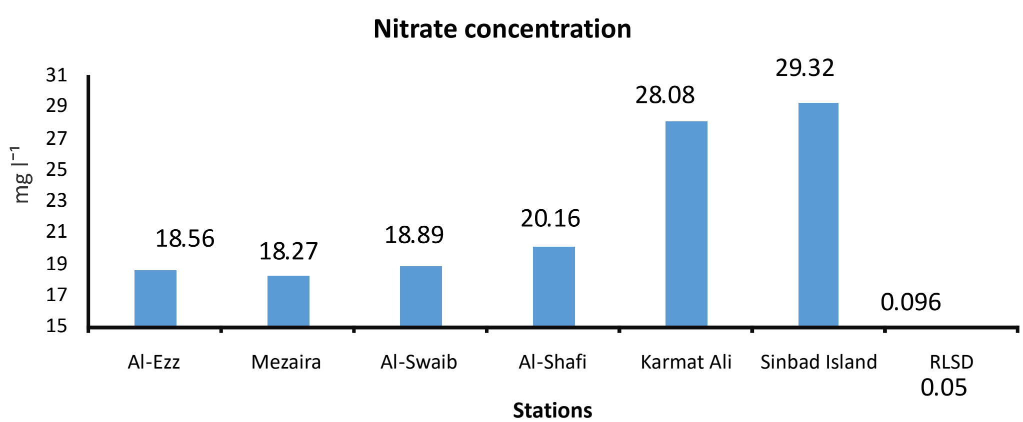

Fig. 10. Spatial change in NO_3 ion values (mg. l^{-1}) during the study period

power station on the right bank of the river, contributes to raising the water temperature, higher values of DO in surface depth water (d1) compared to other depths (d3, d2) for all stations under study, for example the percentage of height was 4.39, 7.54%, respectively, due to the gas exchange between the surface water depth and the air, and the increase in the melting of oxygen in this depth (Xia et al 2019).

Table 2 and Figure 10 show an increase in nitrate ion values in the Sinbad Island station water (29.32 mg l^{-1}), significant differences compared to Karmat Ali Station (28.08 mg l^{-1}), agreed with Hassan *et al* (2011), due to the passage of the river into agricultural areas, as tap water contributes to adding nitrates to the river's water, a negative ions that do not absorb on the surfaces of soil colloids, increased concentration in water (Dušek and Weiner 2000), high population density and the consequent increase in the amount of wastewater, dumped into the river and that is more effective than agricultural wastes (Al-Zorfi et al 2010), While the lowest NO_3^{-1} ion values in Mezaira station (comparison station) reached 18.27 mg l^{-1} , whereas, the values of Al-Ezz Al-Swaib, Al-Shafi and Karmat Ali stations ranged from 18.56, 18.89, 21.61 and 28.08 mg l^{-1} respectively, the variation in the NO_3^{-1} ion values according to the stations under study, due to the area of agricultural lands and the quantities of fertilizers used in it (according to data of the General Company for Agricultural Supplies / Basra), as well as the amount of pollutants that are thrown into the river water, which contributes to raising the concentration of nitrate ion, the percentage of increase in the values of Al-Ezz, Al-Swaib, Al-Shafi, Karmat Ali and Sindbad island stations, compared to the values of Maziraa Station, were 1.58, 3.39, 10.34, 34.93, and 60.48%, respectively.

The seasons have a highly significant effect on the NO_3^{-1} values (Table 2), Figure 11 show that nitrate ion values increased significantly during the winter (23.77 mgl^{-1}) compared to other seasons of the year, the lowest values for the summer were 21.15 mg l^{-1}, the reason for the decrease in values during the summer season, due to the absorption of nitrates by algae, whose growth increases during the summer due to the high temperatures and the availability of nutrients in the river water, while the values increase during the winter season, as rainwater contributes to washing the surface layer of soil that contains fertilizers and which is transported to the river water by puncture water (Al Zorfi et al 2010, Xia et al 2019), as well as high values of DO during the winter (7.98 mg l^{-1}) as in Figure 3., leads to the conversion of the nitrite ion in the wastewater (dumped into the river) to the nitrate ion due to the availability of oxygen necessary for the conversion process, while the value of DO decreased during the summer due to the high temperatures (6.99 mg l^{-1}), reduces the process of converting nitrates to nitrite (Gachter et al 2004).

The values of NO_3^{-1} during the spring and autumn seasons were 21.57 and 22.37 mg l^{-1} respectively, differed significantly from the values of winter and summer, the percentage increase of the nitrate ion value during the winter compared to the values of the spring, summer and autumn seasons was 10.19, 12.38 and 6.25%, respectively

As for the sample site, depending on the cross section of the river, from Table 2 and Figure 12, the nitrate ion concentration increases with significant differences in the water of the right bank (22.72) and the left (22.44) compared to the values in the middle of the river (21.48) mg l^{-1}, the percentage increase in the values of the right and left bank compared to the values of the middle of the river was 5.72 and 4.46%, respectively, the reason for the high NO_3^{-1} values on both sides of the river compared to the values in the middle of the river, to the waters that flow to both sides of the river, as well as the effect of sewage dumped into the river water, which causes the high values (Al-Imarah et al 2001, Hameed and Al-Jorany 2011).

The depth of sample had a highly significant effect on NO_3^{-1} values, as shown in Figure 13, nitrate ion values increased significantly in surface depth waters (22.33) compared to depths between the water column and near the river bed (22.16 and 22.16) mg l^{-1}, respectively, agreed with Xia *et al* (2019), the reason for this rise in NO_3^{-1} values in the surface depth, due to the higher DO values in this depth compared to the other two depths (Figure 5), ammonia converts to nitrate when oxygen is available (Antoine and Al-Saadi 1982), the nitrate ion values were equal in the water of the other two depths of the river (22.16 mg l^{-1}).

The interaction between stations and seasons of the year has a significant effect on NO_3 values (Table 2 and Figure 14), the concentration of nitrate ion increased significantly during the winter season in the stations located to the north of the study area (Al-Ezz, Mezaira, Al-Swaib and Al-Shafi) compared to the spring, summer and autumn seasons, as high temperatures lead to an increase in algae growth, which increases its consumption of nitrates (Al-Zorfi et al 2010), the percentage of decline compared to winter reached 28.25, 21.58, 28.35 and 36.78%, respectively, while the nitrate ion concentration increases in the water of the stations located south of the study area (Karmat Ali and Sinbad Island) during the spring season, the reason was attributed to the saline tide coming from the Arabian Gulf, which carries contaminants with it from the areas it passes through during the tidal process of sewage and sewage discharged into the river water (Hameed and Al-Jorany

2001), despite the high temperatures during this season, the percentage of high nitrate ion concentration in the waters of Karmat Ali and Sinbad Island stations during the spring season compared to the winter season was 13.01 and 45.92%.

The high nitrate ion values in Karmat Ali and Sinbad Island stations during the summer despite the high temperatures during this season, the percentage of high nitrate concentration in the waters of Karmat Ali and Sinbad Island stations during the summer compared to the spring semester was 26.18, 5.02%, due to the effect of the saline tide, on the one hand, and the effect of the sub-rivers that flow its water in the Shatt Al-Arab at the stations of Karmat Ali and Sinbad Island. On the contrary, a decrease in the nitrate ion concentration was observed in the stations located north of the study area during the summer compared to the spring because of the high temperatures during this season (Al-Zorfi *et al* 2010), the percentage of depreciation in the water of Al-Ezz, Mezaira, Al-Swaib and Al-Shafi stations during the summer compared to the spring semester was 2.16, 8.82, 4.31 and 10.21%, respectively. The high concentration of nitrate ion in Al-Ezz, Mezaira, Al-Swaib and Al-Shafi stations

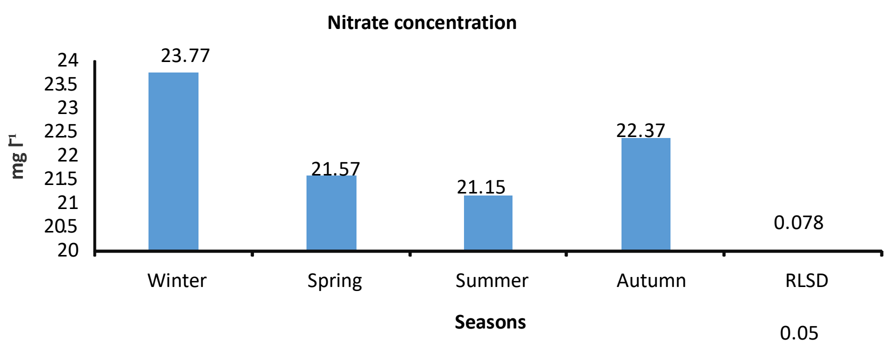

Fig. 11. Temporal change in NO_3 ion values (mg. l^{-1}) during the study period

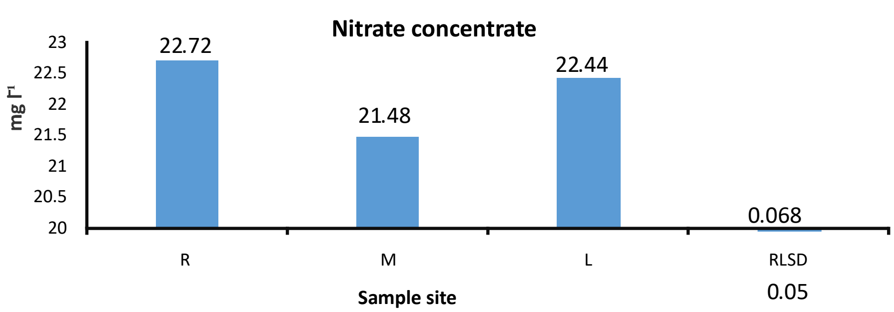

Fig. 12. NO_3 ion values (mg. l^{-1}) for the cross-sectional sampling site

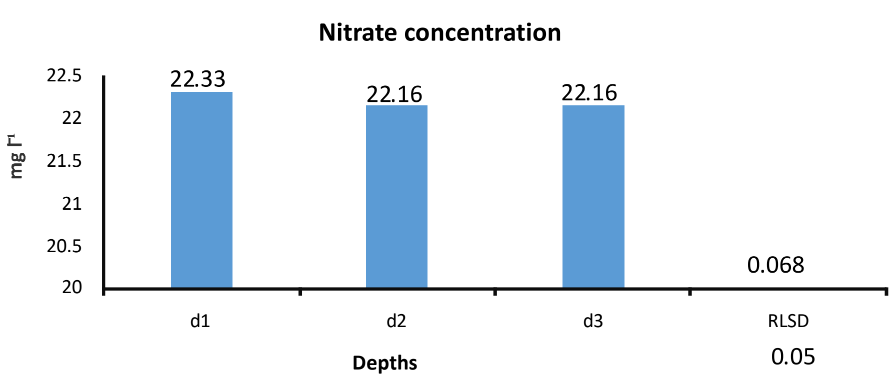

Fig. 13. NO_3 ion values (mg. l^{-1}) for depth of sample site

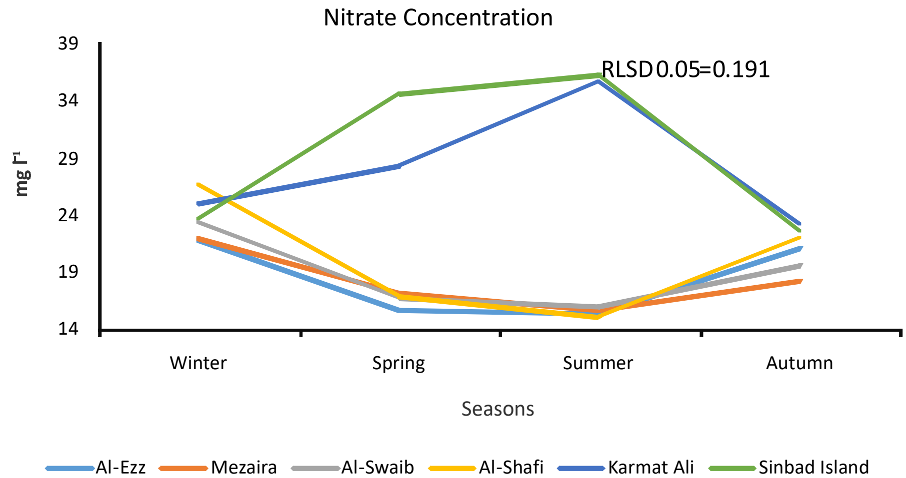

Fig. 14. NO3 ion values (mg. l^{-1}) for interaction between stations and year seasons

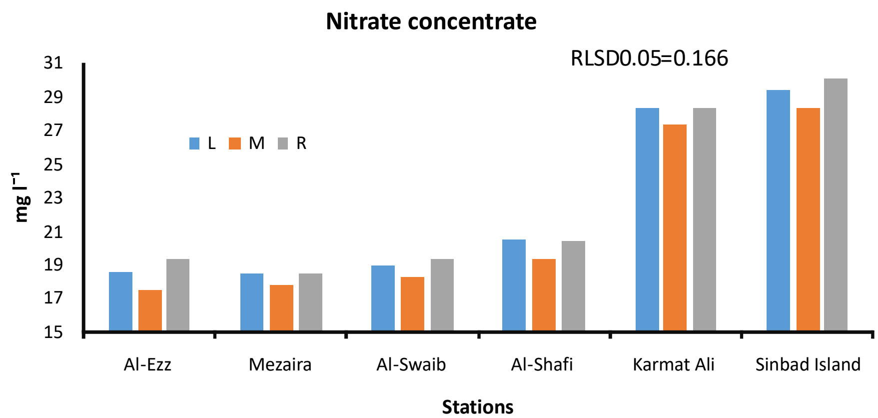

Fig. 15. NO_3 ion values (mg. l^{-1}) for interference between stations and river sampling sites

during the autumn due to the relatively low temperatures compared to the summer, the percentage of increase during this season compared to the summer was 37.40, 15.98, 22.59 and 45.76%, respectively, while it is noticed that the nitrate ion concentration decreases in Karmat Ali and Sinbad Island stations due to the mitigation process of the high water discharge of the river, the percentage of decline compared to the summer was 34.89 and 37.69%, respectively.

The interaction between the stations and the sampling sites according to the river cross section has a highly significant effect on the NO_3^{-1} values (Table 2), from Figure 15 the nitrate ion concentration increased significantly in the waters of both banks of the river compared to the middle of the river for the stations studied, especially the Sinbad and Karma Ali stations, due to the effect of sewage and wastewater discharged on both sides of the river (Hassan and *et al* 2011), whereas the movement of water in the middle of the river, which contributes to mixing the water (the principle of dilution), leads to a decrease in the values in the middle of the river's cross section, the values on the left and right banks were close to the stations studied, the values of the right bank are high in Al-Ezz, Al-Swaib, Karmat Ali and Sindbad Island, the percentage of high nitrate concentration in the Right Bank compared to the Left Bank was 4.18, 1.62, 0.07, and 2.3%, respectively, while the value of the left bank is high in Mezaira and Al Shafi stations, the percentage increase in values of the left bank compared to the right bank was 0.26 and 0.09%, respectively.

CONCLUSIONS

Low values of DO (considered as an indicator of river water quality) in stations south of the study area (Karmat Ali and Sinbad Island). The high nitrate ion values in these two stations compared to the stations located to the north of the study area (Al-Ezz, Mezaira, Swaib and Al-Shafi), high pollution rate south of the study area, Which affects the water quality of the Shatt Al-Arab in this period of time (in 2018). On the contrary, it is observed that the DO values are high in the northern part of the study area (Al-Ezz, Mezaira, Al-Swaib and Al-Shafi stations) and the nitrate ion values were low and a low pollution rate. All the values were within the normal limits for WHO (2006).

REFERENCES

Abbawi SA and Hassan MS 1990. *Practical engineering for the environment*. First edition. Water tests. University of Al Mosul. Iraq.

Abdel-Razzaq UJ, Salman SD and Al-Taie MM 2015. Environmental study of the Rotifers of the Hilla River. *Babylon University Journal/ Pure and Applied Sciences* **3**(23): 939-954.

Mays Sdjan A and Abdulameer S 2011. Shatt al-Arab channel field study. *Basra studies Journal* **12**(1994): 288-331.

Al-Hejuje MM, Al-Saad HT and Hussain NA 2017. Assessing the organic pollution and agriculture activity of surface water at Shatt Al-Arab Estuary Southern of Iraq. *Indonesian Journal of Marine Sciences* **22**(4): 161-168.

Al-Imarah FJ, Allaywi YJ and Monais FS 2001. Monthly variations in the levels of nutrients and chlorophyll in Shatt Al-Arab water. *Mar. Mesopot* **16**(1): 347-357.

Al-Khuza'i DKK 2014. The chemical and physical properties of common water in Basra Governorate and assessing its suitability for irrigation. *Basra Research Journal (operations)* **40**(2B): 26-44.

Al-Lami AA, Sabri AW, Mohsen KA and Al-Dulaimi AA 2001. Environmental Effects of Tattler Arm on the Tigris River, A-Physical and Chemical Properties. *The Scientific Journal of the Iraqi Atomic Energy Organization* **3**(2): 122-136.

Al-Omar MA 2000. *Environmental pollution*, Wael Publishing House, Amman, p. 294.

Al-Saad HT, Al-Hello AA, Al-Kazae DA, Al-Hello M, Hassan WF and Mahdi S 2015. Analysis of water quality using physical and chemical parameters in Shatt Al- Arab Estuary, Iraq. *International Journal of Marine Science* **5**(49): 1-9.

Al-Shawi EJ and Al-Rubaie AA 2007. A monological study of the southern part of the Tigris and Euphrates rivers and the extent of their influence on the physical and chemical characteristics of the estuary of the Shatt al-Arab. *University Teacher Magazine* **6**(11): 125-137.

Al-Zorfi SKL, Al-Aidani TYM and Matar AI 2010. Some physical and chemical properties of Hor Ibn Najm water, Najaf Al-Ashraf. *Diyala Journal* **2**: 272-299.

Antoine SE and Al-Saad HT 1982. Limonological studies on the polluted Ashar canal and Shatt Al- Arab River at Basrah. *Internationale Revue Der Gesamten Hydrobiologie* **67**(3): 405-418.

Boyd CE 2000. *Water quality*. *An Introduction*. Klumer, Academic publishers, London, pp 252.

El Morhit M and Mouhir L 2014. Study of physic-chemical parameters of water In the Loukkos River Estuary (Larache, Morocco) .2019 Springer Nature Switzerland AG. 3000811494.

Falih HA and Rashid KA 2016. Study of some physical and chemical properties of the Tigris River in the city of Baghdad. *Plant Archives* **20**(2): 4002-4012.

Gachter R, Steingruber SM, Reiuhardt M and Wehrli B 2004. Nutrient Transfer from soil to surface water. Differences between NO3 & PO4. *Aquatic sciences* **66**: 117-122.

Gatea MH 2018. Study of water quality changes of Shatt Al- Arab River South of Iraq. *Journal of University of Babylon for Engineering Sciences* **26**(8): 228.

Hamdan AN 2015.Variatio on effect of discharge on total dissolved solids in Shatt Al-Arab River. *The 2nd International Conference of Building, Construction and Environmental Engineering* (BCEE 2-2015).

Hameed AH and Al-Joorany H 2011. Investigation on nutrient behavior along Shatt Al- Arab River, Basin, Iraq. *Journal of Applied and Sciences Research* **7**(8): 1340-1350.

Hamzah SA 2019. Shatt Al-Arab waterway hydrology and environmental repercussion. *National for forum Onal and Ideology Researches Culture* **1**(37): 335-358.

Hassan WF, Hassan LF and Jassim AH 2011. Flowing effects industrial pollution polluted water near the discharge in Basra Governorate, Iraq. *Research Magazine Basra* (operations) **33**(I): 42-53.

Kendall P 2000. *Drinking Water Quality & Health*. Colorado State, University Cooperative.

Moyel MS and Hussain N 2015. Water quality assessment of Shatt Al-Arab River, Southern Iraq. *Journal of Coastal life Medicine* **6**: 459-465.

Rahman A, Islam M, Hossain MZ and Ashan MA 2012. Study of the seasonal Variation in Turag River water quality parameters. *African Journal of Pure and Applied Chemistry* **6**(10): 144-148.

WHO. World Health Organization. 2006. *Environmental quality*, part1X-Water, subpart 1. Water pollution control.

Dušek A and Weiner ER 2002. Applications of Environmental Chemistry. A Practical Guide for Environmental Professionals. *Photosynthetica* **40**(2): 226-226.

Xia L, Xinyi X, Guoyi H, Xiarui S, Pejia W and Kaidao F 2019. Bacterial abundance & physiochemical characteristics of water and sediment associated with hydroelectric dam on the Loncang River, China. *International Journal of Environmental Research and Public Health* **16**(11): 2031-2053.

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