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STUDY THE EFFECT OF DISCHARGE AND ENVIRONMENTAL AND HUMAN FACTORS ON CHEMICAL AND HYDRAULIC PROPERTIES OF SHAFT AL-ARAB WATER USING MATHEMATICAL MODELING TDS. ANT TURBIDITY

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Abstract:

A field study was carried out on four selected sites along the course of the Shatt al-Arab, including two sites north of the river: the site of Al-Sada Al-Nour and the site of the paper factory, a site in the center of Basra, which is the site of Al-Ashar, and the site south of the river, which is the site of Seyhan. This study lasted a whole year and was divided into four semesters, extending from the summer of 2021 until the spring of 2022. The study aims to identify the pattern of salt penetration into the course of the Shatt al-Arab by following up the spatial and temporal variation of the values of total dissolved solids and turbidity values of river water and the impact of water supplies coming from the Tigris River and the movement of tides. Samples were collected from the four sites, for the four seasons, for three depths and by three replicates. The experiment treatments are distributed into three replicates by using a factorial experiment conducted in a randomized complete block design (RCBD). The results of the study showed a significant effect of the study factors on the values of total dissolved solids and turbidity values, with a spatial and temporal variation of values, and significant differences between the coefficients and the values of total dissolved solids ranged between 1229.71 and 5895.27 at the site of Al-Nour and the site of Seyhan, respectively. There was an aggregate increase in values for the location of the paper mill and the site of the publican, while the increase was double for the site of Seyhan, and the rates of increase ranged between 8.74 and 135.35%. In the turbidity values ranged between 13.90 and 36.49 NTU at the site of the paper mill and Seyhan respectively. Based on the time factor, turbidity values varied between 18.09 and 27.30 NTU for winter and spring, respectively.

Keywords: Spatial and temporal variation, turbidity, aggregative increase

INTRODUCTION

Total dissolved solids (TDS) are defined as a mixture of inorganic salts and organic substances, and the nature and quantity of total dissolved solids in water depend on the geomorphology of the region (Taher, 2016). Between Hameed and Al-Jorani (2011), the entry of large quantities of Gulf salt water due to the salt front coming from the Arabian Gulf through the phenomenon of tides affects the number of dissolved substances and the volume of discharge in the Shatt al-Arab, and the climatic conditions prevailing in the region have an impact on that, as well as the change of river discharge seasonally depending on the amount of water received by it following the dissolved substances in quantity and quality. Explained by Al-Asadi, (2012).There is a wide spatial and temporal variation in the concentration rates of dissolved solids through the results of laboratory analyzes of Shatt al-Arab water models for measurement stations in their study, as the annual rate reached 1984 mg litre-1 in Rabat station and the rate in Mahila station increased to 2272 mg litre-1, while the annual rate of dissolved substances concentration increased significantly to 23412 mg litre-1 at the Faw station, while the temporal variation of the rates of concentration of dissolved substances in the measurement stations increased the rates During the summer in the Rabat and Mahila stations, where it reached 2408 and 2931 mg liter-1, respectively, to be the highest rates recorded during the study period, While the autumn season recorded the

lowest recorded rates, reaching 1408 and 1696 mg litre-1 for the two stations, respectively, and indicated that the hydrological conditions are completely different in the Faw station from the Rabat and Mahila stations, being an estuary area, as the average concentration of dissolved substances increased to 33169 and 16746 mg liter-1 during the autumn and spring seasons, to record the highest and lowest rates of dissolved substances concentration in the river water during the study period and respectively. Total solids sources include industrial water discharge, wastewater, fertilizers, road runoff, soil erosion and washing, and total dissolved solids values for Shatt al-Arab water ranged during the study period (142 and 5566) mg l-1 in the paper lab and FAO respectively, and the values were higher in spring and autumn of summer and winter (Al-Saad et al. 2015). The results of a study by Lateef et al.,(2020) proved that the extent of variation between the highest and lowest value of total TDS exceeded the criteria specified by the Iraqi standards, which divided the Shatt al-Arab into two parts, including areas from northern Basra to the city center with a value of TDS 1000 mg L-1 and areas from Muhaila to Al-Faw with a value of 1500 mg L-1, as it reached 7700 mg L-1 in the Ashar area within the first section of the Shatt al-Arab and 8500 mg L-1 in the area of Muhaila within the section The second during the winter season (December 2018), it can be seen that the concentration of total dissolved solids has generally increased downstream, There is a positive correlation between high temperatures and the concentration of dissolved solids in the Shatt al-Arab as a result of high rates of evaporation, which led to an increase in salt concentration, moreover, a negative relationship was found between dissolved solids and the amount of water that is discharged into the river.Al-Hashimi and Alnedawy, (2019) in a study that included ten stations, namely Tigris, Euphrates, Sweib, Al-Shaqi, Al-Maqal, City Center, Abu Flos, Sihan, Duwaib, and Al-Faw, that the decrease in water discharge of the Shatt al-Arab until it reached 40 m3 s-1 by the end of 2015, which led to the penetration of water during the tide, which forms salt water, and as a result, the salinity in the river water increased, and the salinity values varied between the stations spatially as well as temporally for the months of the year, as the lowest values reached the first station During the month of January, it was 0.85 g L-1, while the highest values reached in July and at the Faw station and amounted to 31.30 g L-1. The results of the field measurement of a study conducted for the Shatt al-Arab stream showed that there is a clear spatial and temporal variation of salt concentrations, as there were differences in salt concentrations between the study stations and reached the highest values at the Faw station at a rate of 23416 mg liter-1 while the values at the Qurna station reached 1482 mg liter-1 as the lowest rate of values between the measuring stations, and a large temporal variation was found in the rate of dissolved salt concentration, as the summer witnessed a significant increase in values in most stations and at a rate of 28368 mg L-1 while the lowest average values were recorded at 1476 mg L-1 during the winter, and the low differences between salt concentrations in the water column indicate the presence of strong mixing and weak stratification in the Shatt al-Arab during the four seasons (Al-Ghalbi and Al-Asadi, 2019). Turbidity is an indicator of water purity and the Shatt al-Arab River contains high turbidity water that exceeded the permissible values in ecosystems, as the values ranged between (0.80-163.00) FTU and one of the most important sources of water turbidity is the erosion of river banks and soil and the discharge of waste in urban areas and the materials carried by runoff (Al-Saad et al., 2015).

Jassim and Hussain,(2021) found in their study of the middle section of the Shatt al-Arab and two stations of this section, namely Al-Baradiyah and Muhila, and the samples were collected monthly for the period from July 2019 to June 2020 and for two layers, the first is the surface layer and the second near the bottom, that the lowest value of turbidity was 2 NTU at the surface layer at the Mahila station in June 2020, while the highest values of turbidity were recorded at the bottom of the Muhaila station, as it reached 70 NTU, and the lower layer recorded the highest values for turbidity of the surface layer at both stations during tides, and statistical analysis proved a significant difference between stations, months, surface and bottom samples. Mahdi, (2015). Show Through its study, which extended along the course of the Shatt al-Arab and six stations, namely Qurna, Paper Factory, Sinbad, Al-Ashar, Al-Sibah, and Al-Faw, turbidity is one of the important factors that have a close relationship with the purity and clarity of the water and is considered an indicator of the presence of suspended materials in the water, and the turbidity values reached 25.02, 15.40, 31.03, 9, 59.8 and 120FTU for the studied stations, respectively. In a study by Hamdan et al. (2018). Along the Shatt al-Arab, which included 37 sites distributed on the main channel and some of its branches, it was found that the turbidity values of the main channel of the river within the acceptable limits of international standards, as the lowest values reached 8.83 NTU, while the highest values for turbidity were recorded 206 NTU, which were in some branches such as Al-Khora, Al-Ashar, and Al-Khandaq, thus exceeding the turbidity values in the branches of the main channel acceptable limits of standards. Al-Shamary et al. (2020) explained in their study of Iraqi marine waters, in which he chose three stations for the study, namely the mouth of the Shatt al-Arab and the intermediate part between Iraqi marine waters and the estuaries of rivers and Iraqi marine waters near Khor Al-Amaya, and the study extended for a full year from January to December 2018, that there are large and significant differences in turbidity values between the three study stations, and the highest values for turbidity were recorded in the first station and amounted to 645 NTU during the month of October, in When the second station recorded during the month of August a value of 600 NTU and the third station reached the highest value of 500 NTU during the month of November. And between Moel, (2010) through his study, which included four stations on the Shatt al-Arab and for a period of one year from July 2009 to June 2010, that there are monthly changes in the values of turbidity water for different study stations, as the highest values reached 39.3 NTU in the first station and in July, and recorded the lowest values at the same station, but in February and amounted to 9.8 NTU, and also showed that there are significant differences between the months of the study and the different stations in the values of turbidity.

MATERIALS AND METHODS:

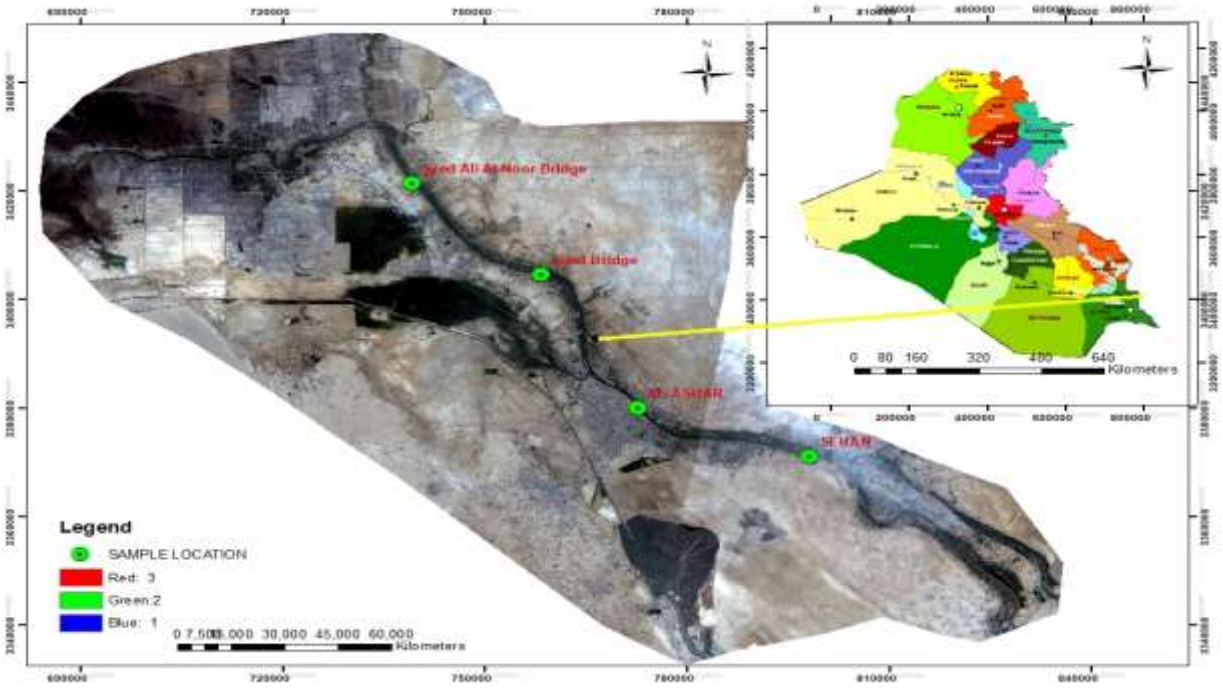
Work Study Area:

The study was conducted on the course of the Shatt al-Arab and after conducting a field survey of the course of the river, four representative stations were selected for the study, (Fig. 1 and Table 1) showing the locations of the stations and their events.

Table (1) The coordinates of the locations of the measurement stations.

Sq.	Stations	Longitude	Latitude
1	Syed Ali Al-Nour Bridge	$47^0$29'56.66'E	$30^0$54'6.52'N
2	Saad Bridge	$47^0$42'3.58'E	$30^0$44'41.82'N
3	Al- Ashar	$47^0$5035.01E	$30^0$31'15.49'N
4	Sehan	$48^0$11'42.69'E	$30^0$19'35.70'

Photo (1) Locations of the study stations.



The climate of the study area:

The prevailing climate in the study area is characterized by being a semi-tropical continental climate, as can be observed in the prevalence of two seasons mainly the winter season and the summer season, and despite the small amount of rain falling in this region, its fall is concentrated during the winter, and the summer season was characterized by high temperatures that exceed 50 C° on some days, especially in July and August, that the prevailing winds in the region are the north and northwest winds (21). The study included three main factors:

The study station factor (four stations) is symbolized by (S). As the first station is located at the Syed Ali Al-Nour Bridge, south of Qurna, (S_1), the second station is in the Hartha area at Saad Bridge (S_2), and

the third station was at the city center, Al-Ashar area, (S_3) and the last station was at the Sehan area near the border station, (S_4) The time factor is symbolized by the symbol (T) and includes the study period for four seasons, namely, summer semester / September (T_1), autumn semester / October (T_2), winter season / December (T_3) for the year 2021 and Spring/April (T_4) semester for 2022.

Depth factor:

It included dividing the water column in each stretch into three equal depths, taking water samples from each depth (D_1), the second depth (D_2), and the third depth (D_3). A bottle with a tight stopper was used, the opening of the bottle was controlled by a wire and the bottle was lowered to the required depth using a tape measure.

Total dissolved solids (TDS).

Were estimated by filtrating the volume of 50 ml of the aqueous sample by GF type filter paper with an air vacuum, then drying the filtrate at a temperature of 180 ° C, then calculating the dry weight and repeating the process until the weight is stable. (APHA, 2017). 3.2.5 Turbidity Water turbidity was measured by a turbidity meter Lovibond type and expressed the results in units NTU.

RESULTS AND DISCUSSION

Total dissolved solids: -

Water quality in the Shatt al-Arab is affected by chemicals transported with water flowing in the riverbed and coming from the Arabian Gulf during the tide state as well as coming from the Tigris River or trocars and waste are thrown into the riverbed ((Moyel and Hussain, 2015. The results of the statistical analysis showed that there is a significant effect of the station factor on the values of total dissolved solids. Figure 1 shows the existence of significant differences in the values of dissolved solids The total of the studied stations, and that the values of TDS vary spatially as they increase

towards the mouth of the river, and the lowest average values were recorded at the station of Al-Sada Al-Nour and amounted to 1229.71 mg liter^{-1}. While the values increased downward to reach the highest values at the Seyhan station and

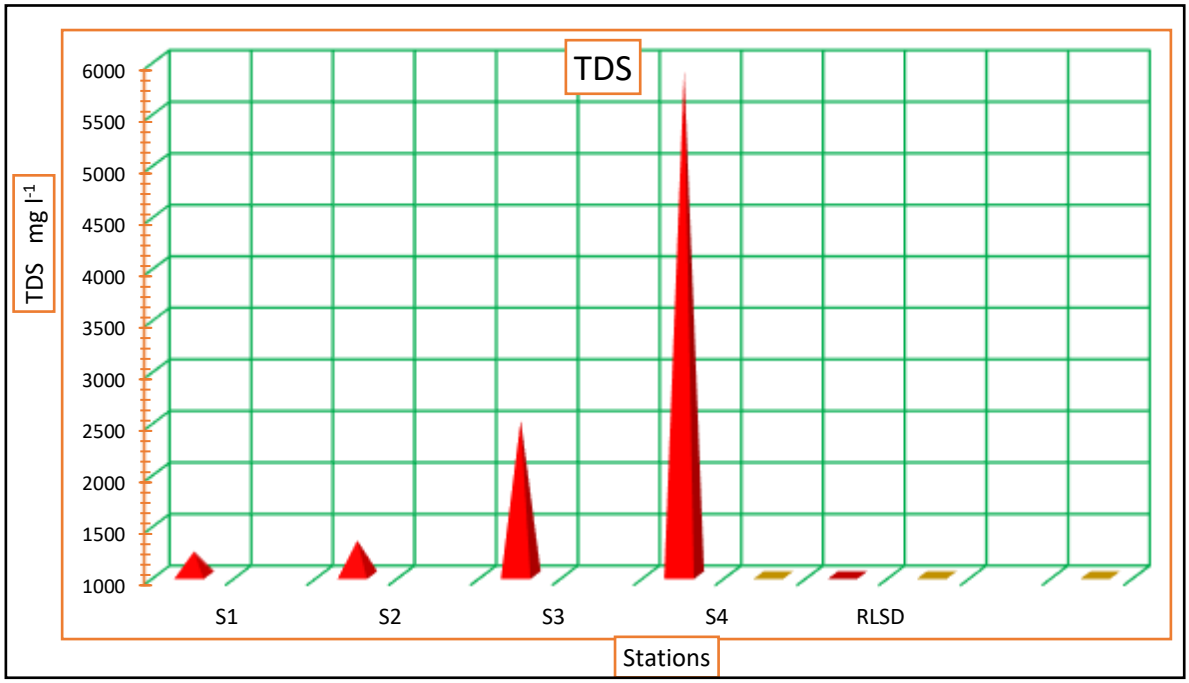


Figure 1 Total TDS values for study stations.

Amounted to 5895.27 mg L^{-1} due to the effect of salt water coming from the Gulf due to the effect of the tidal movement that penetrates whenever the water revenues coming from the upper river decrease, rivers that do not have enough water flowing through them to remove and dilute salts and other mineral pollutants in them that are produced by humans and other activities and sources. These pollutants can accumulate and adversely affect water quality (Jonnalagadda and Mhere 2001; Chen, He, and Cui 2003).

When comparing the increase in the TDS values of the studied stations, we find that the percentage of increase in the paper mill station for the Al-Sada Al-Nour station amounted to 8.74% and by 4.04 mg liter^{-1} per 1 km, while the percentage of increase in the Al-Ashar station for the paper mill station amounted to 87.33% and by 37.31 mg liter^{-1} per 1 km, while the percentage of increase in the total amount of dissolved materials for the Seyhan station for the Ashar station was 135.35% and by 75.51 mg liter^{-1} per 1 km. This indicates a cumulative increase in the first and second stations and between the second and third stations, while it was a double increase in the Seyhan station compared to the other stations, and this indicates that there is a source of salts and pollutants in this station that exceeds the salinity of local and urban sources, and the source of salt tide penetration, (Hamdan, et al., 2019). The values of total TDS varied temporally, it was found that there is a significant effect of the time factor on the values of total TDS according to the results of the statistical analysis. Figure 2 showed that there are significant differences between these values for the seasons and that the highest rate of values recorded in the summer season amounted to 3364.74 mg liter-^{1} and the values decreased in other seasons to reach the lowest values of 1963.67 mg liter^{-1} in the spring season, and when calculating the increase in values during the summer season from the rest of the seasons, we find that the rates of increase amounted to 12.92 and 24.99 60.39% respectively for the autumn, winter and spring seasons, which is considered a flood season as it increases in Revenues of low-salinity water coming from upstream and therefore low TDS values, While the high values in the summer season are due to the scarcity of water revenues of the Shatt al-Arab on the one hand, the progress of saline water during the tide on the other hand, as well as the increase in evaporation rates due to the significant increase in temperature in this season, as well as the increase in agricultural and human water consumption rates (Abdullah et al., 2017).

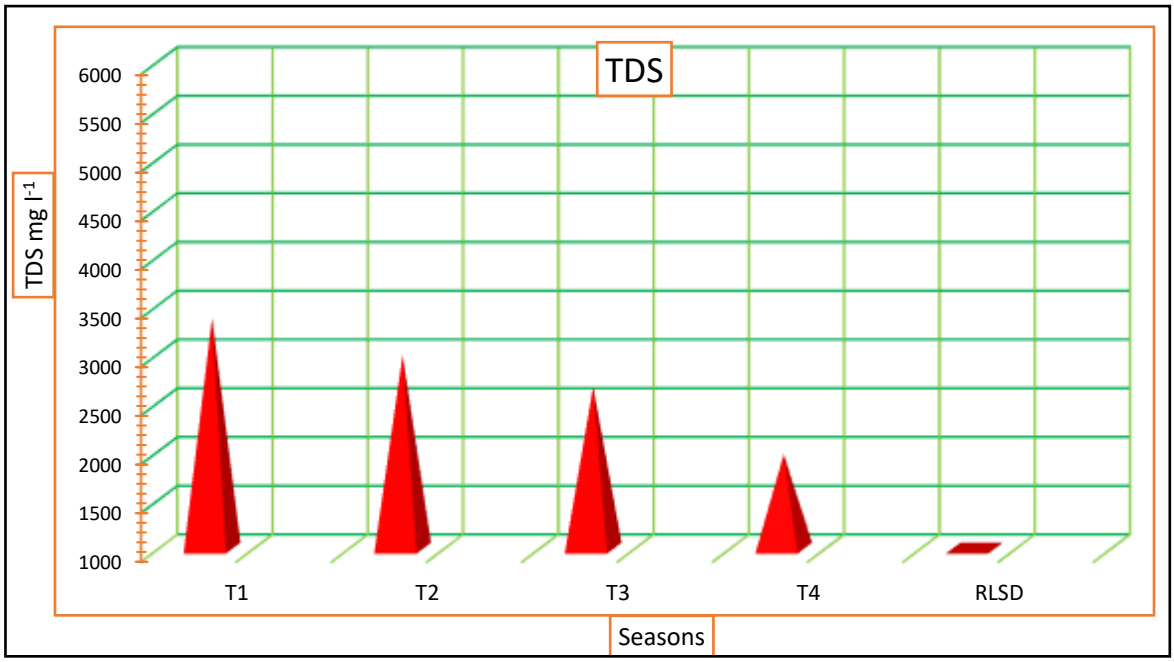


Figure 2 Total TDS values for the seasons studied

Through the results of the statistical analysis, there were significant differences between the average values of total dissolved solids for the first and third depths only, and there were no significant differences between the values for the first and second depths, as well as for the second and third depths, as the values reached 2696.63, 2738.64 and 2789.97 mg liters^{-1} and for the first, second and third depths respectively. This is due to the large distance between the first and third depth and the effect of the density of salt water, which makes salt water heavier and settles in the depths, while less saline water rises to the surface depths and this situation overcomes the state of good mixing of Shatt al-Arab water, which does not make significant differences between the convergent depths such as the first and second depths and the second and third depth (Stajduhar and Lipvac, 2015) and, (Al-Ghalbi and Al-Asadi, 2019).

The results of the statistical analysis showed that there is a significant effect of the interference between the station and time factors in the values of total dissolved solids, as the TDS values varied between stations according to the seasons of the year, and the highest differences between the values for the seasons studied were recorded at Seyhan station and these differences decreased significantly at Al-Ashar station and these differences between the values in the paper factory and Al-Sada Al-Nour stations disappeared, and the Seyhan station witnessed the highest values of TDS and that was in the summer and with a significant difference from the values recorded in the seasons The differences between the values for the summer season were graded with the autumn season, then increased with the winter season, and then reached the highest differences with the spring season (Fig. 3).

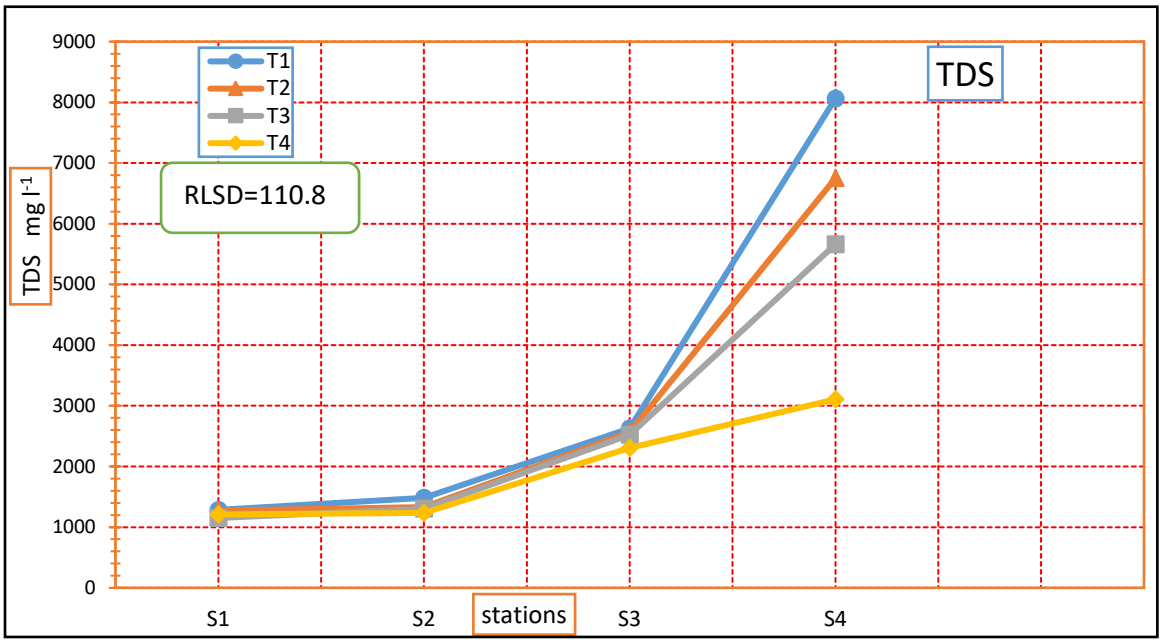


Figure 3 Binary interference between station and time factors in the values of total TDS.

This is because the summer season is the season of water scarcity if the discharge of the Shatt al-Arab River decreases and after the Seyhan station from the sources of river feeding coming from the Tigris River and its proximity to the mouth of the river and tidal currents with salt water, in addition to the high rates of evaporation from the riverbed and the increase in water consumption, which leads to an increase in the concentration of total dissolved solids in the river water, unlike in the spring, which is an abundant season of water, as the discharge of the river increases and decreases Evaporation rate of relatively low temperatures and thus the concentration of total TDS decreases in River water, (Al-Khuzaie, 2014) and (Al-Fartusi, 2018).

Turbidity:

The results of the statistical analysis showed a significant effect of the measurement station factor in the values of turbidity rates and Figure 4 showed that there are significant differences between the turbidity values of the studied stations, as the highest values at Seyhan station were 36.49 NTU, while the lowest values were recorded at the paper mill station and amounted to 13.90 NTU.

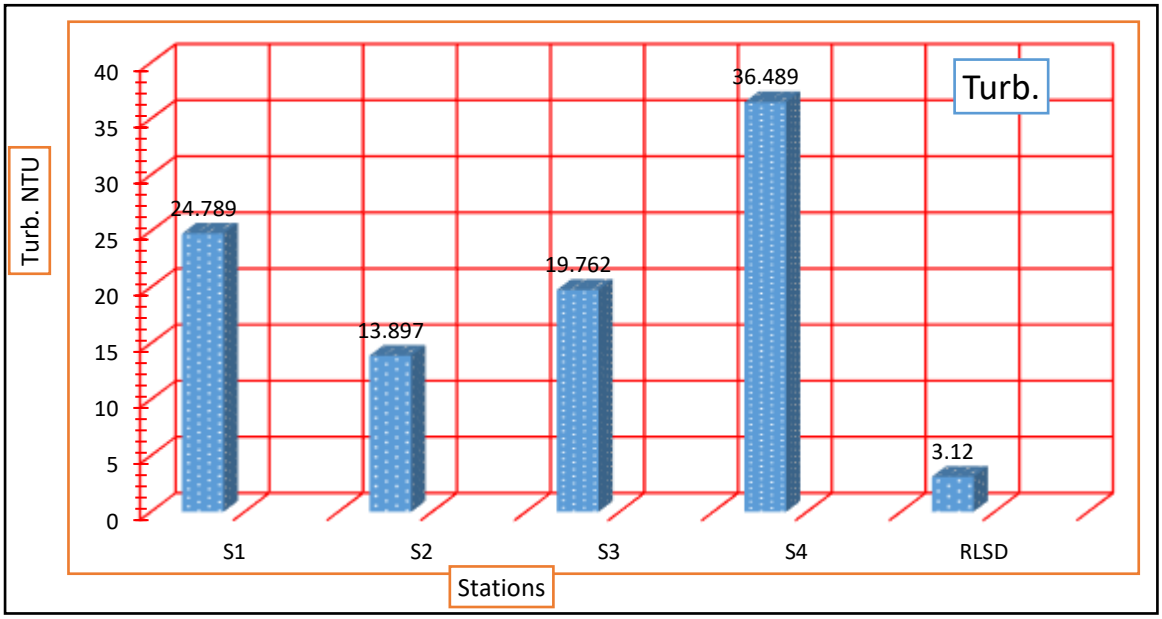


Figure 4 Effect of measurement station on the values of turbidity rates in the waters of the Shatt al-Arab.

The results of the statistical analysis also showed that there is a significant effect of the time factor on the turbidity values.

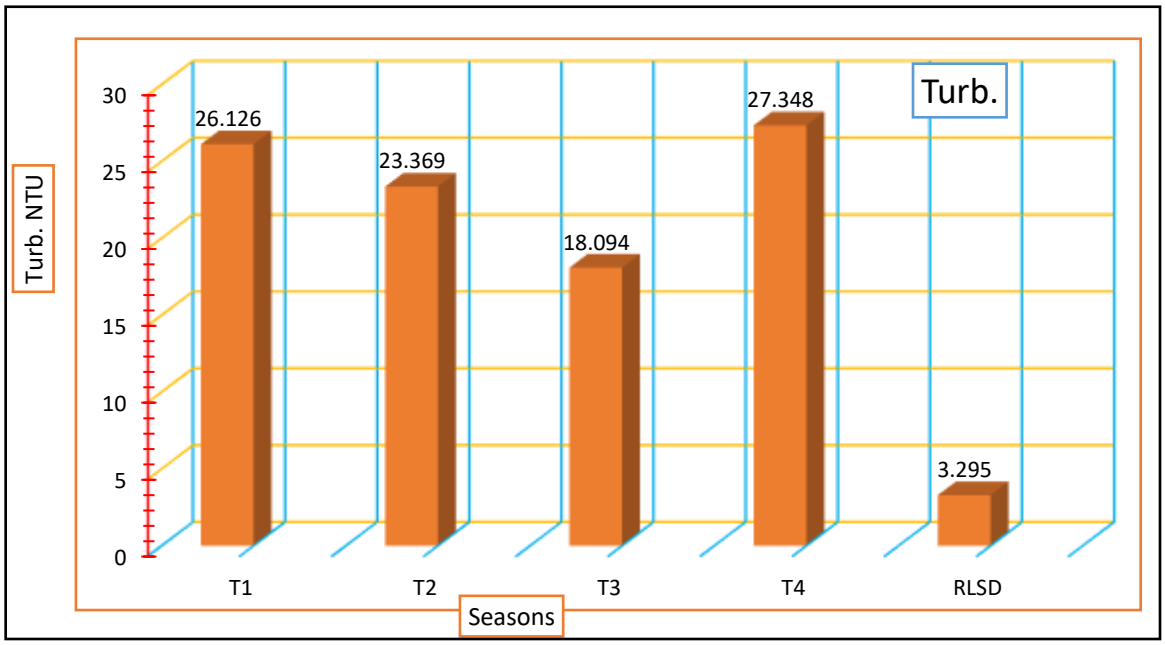


Figure 5 showed that there are significant differences between the turbidity values for the seasons studied in general, except for the differences between Figure 5 Effect of measurement time on the values of turbidity rates in Shatt al-Arab waters.

summer and autumn, summer and spring were not significant, and the highest values were recorded during the spring and amounted to 27.3 NTU and the lowest values reached 18.09 NTU during the winter, This increase in turbidity values at the Seyhan station is due to the effect of wave movement and continuous carving operations on the sides and bottom of the channel, as well as to the movement of ships and boats in that area, and to the increase in the amount of suspended soft sediment, which increases with the increase in the penetration of the tidal mass coming from the Gulf, as well as the increase in hard and negative projectiles in the riverbed, which leads to an increase in turbidity values (Prathumratuna, et al., 2008) and Al-Malikey, 2012).

The results of the statistical analysis showed that there is a significant effect of the depth factor on the turbidity values, and Figure 6 showed that there are significant differences in the turbidity values between the studied depths, except for the difference between the second and third depth, as the values reached 20.35, 24.49 and 26.37 NTU for the studied depths, respectively.

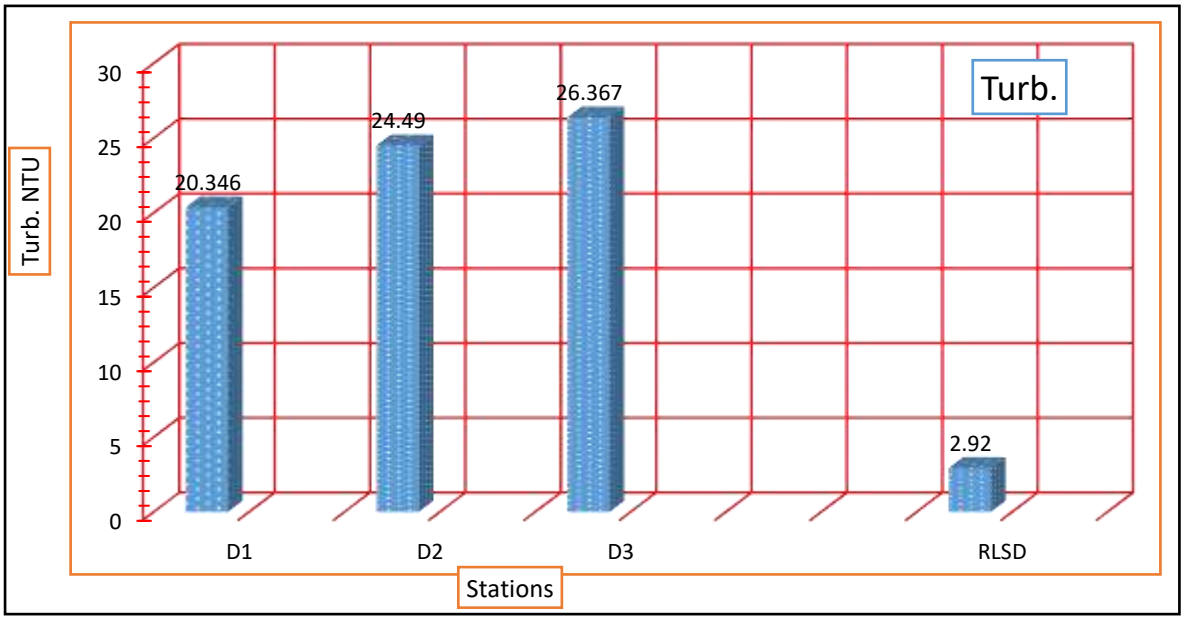


Figure 6 Effect of depths on values of turbidity rates in Shatt al-Arab waters.

The results of the statistical analysis showed that the bilateral interference between the station factors and the measurement time has a significant impact on the turbidity values in the Shatt al-Arab waters, as the variations in values

between the seasons of the year vary according to the stations studied. And between Figure 57 that the highest variations appeared between the summer and winter seasons and decrease these variations between the other seasons at the same station, and at the station Ashar we notice a decrease in variations in values between the seasons, and then widen slightly in the station of the paper mill these variations and return to decrease in the station of Al-Sada Al-Nour This variation in disparities is due to the decrease in water revenues from feeding sources and the penetration of the marine water mass, in addition to the high temperatures in the summer and the increase in evaporation rates, as well as the punctured water and the soil particles it carries. As well as high winds and the formation of dust storms, (Lateef, 2020) and (Taher, 2016).

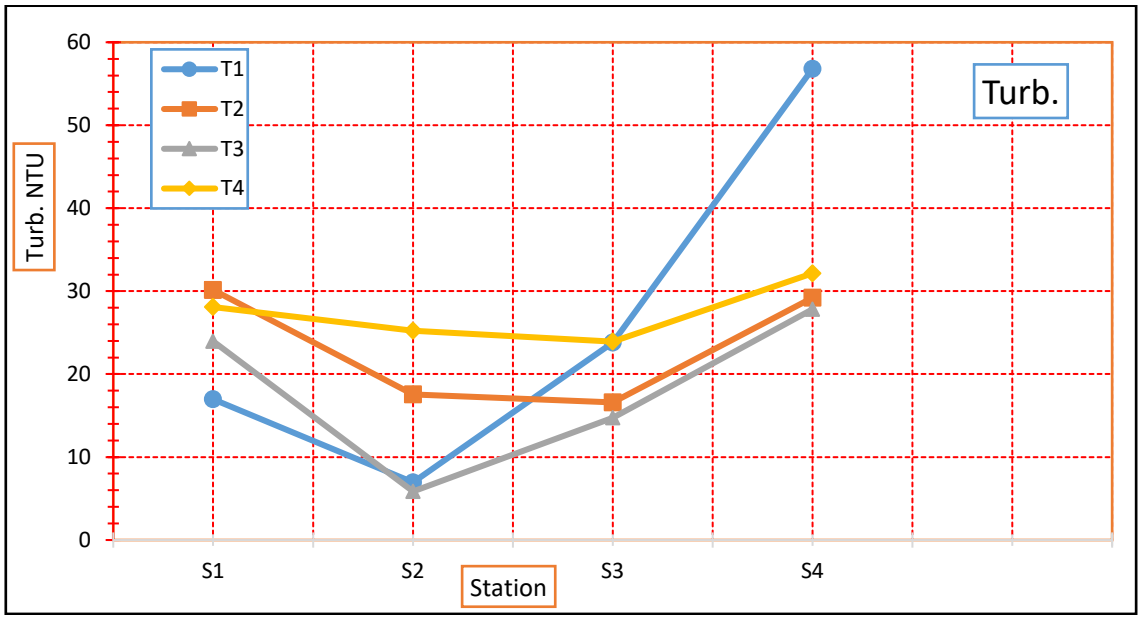


Figure 7 Effect of binary interference between station and time factors on turbidity rate values in Shatt al-Arab waters.

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