NUTRIENTS LOADS AT SHATT AL-ARAB RIVER IN BASRA CITY-IRAQ

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ABSTRACT

Fourteen sampling stations were selected within the study area during the summer and winter periods, also during the morning and evening times for the same day, starting from the Shilha location north of Al-Haritha to Al-Bahadriyah location north of Abu Al-Khasib, which represents the section that contains dense population at Basra city center .The study included the inputs of nitrates, phosphates and some water properties of Shatt Al-Arab river. The nutrients load was used to identifying the state of water and nutrient movement in this part of the river. The study showed that the phosphate and nitrates have not transfer out of this river section. Also there is no significant impact of river branches on the water quality of the Shatt Al-Arab River because of the low water discharges from these branches compared to discharge of the Shatt Al-Arab.

No: of Tables: 03 **No: of Figures: 07** **No: of References: 32**

INTRODUCTION

The water occupies around 66 % of the earth's surface. Rivers and lakes are considered as most important source of fresh water for human use and consumption (Karamouz *et al.,* 2003). In which they form dynamic system and might changes their nature several time during their course .They hold a horizontal and continuous one-way flow of a significant load of nutrients in dissolved and particulate nutrients from both natural and anthropogenic sources (Bakan *et al*. , 2010) .

The quantity issues of water was due to agricultural water extensive use, and the quality issues was due to point and non-point pollution sources Paredes-Arquiola *et al*. (2010).

The Shatt al-Arab River formed by the confluence of Euphrates and Tigris rivers combined near the town of Qurna in the south of Iraq. Shatt al-Arab River is a 195 km long tidal river flowing south-eastwards, passing along the city of Basra and Abadan city in Iran , subsequently the Faw town and from that spot, a final 18 km stretch where it discharges into the Gulf (Abdallah , 2016) .

The Shatt Al-Arab width increases from 250 m downstream of the confluence to 700 m when entering the Basra city center. The water depth varies from 6 to 13 m during dry periods (Alhello &Al-Obiday 1996) .

Shatt Al-Arab river is the main water source for livings in that region. It supports agricultural and industrial practices, navigation activities and eco system biodiversity. The water was diverted for irrigation purpose mainly for grain production in the upper course and palm forests in the lower course. Several water treatment plants divert water for domestic uses along the river. The rural communities, for whom agriculture and livestock is their main livelihood, use the water system for their activities and discharge their waste into it. Medium and large fishing , transport boats, and vessels were navigating to and from the Gulf (Dinar, 2016).

In addition, the Shatt Al-Arab receives sewage and industrial wastewater produced inside Basra province, Iraq. Several large factories, a paper mill, power stations, petrochemical industries, and refinery plants located along both sides of the river are known to discharge processed water.

Most of previous studies on nutrients in this area were aimed primarily to supporting biological work. However, it was indicated that the waters of this estuary are rather rich in nutrient salts. These salts could be considered as potential pollutants if found in high loads more than certain levels. They lead to sudden increases in the quantity of algae, and after their death, they decompose consuming substantial amount of the available dissolved oxygen (Mahdi, 2009).

Basrah city is partially equipped with a proper sewer system which seems to be rather inefficient. Untreated domestic sewage is discharge into Basrah sub Rivers via numerous sewage pipes, and runoff from civil area. As a result, sub rivers have gradually changed from irrigation and navigation canals into absolute open-air polluted water drains with varying pollution levels from which pathogens have repeatedly been isolated.

The polluted waters of the river branches which are enriched with organic and nutrients with relatively low concentrations of dissolved oxygen enter Shatt Al-Arab and have some effects on its environments. These polluted waters are distributed in the river by water currents and turbulent mixing processes.

Nitrogen (N) is an essential nutrient for plants. Small amounts are a natural component of healthy river, but agricultural and urban land use can add more nitrogen to waterways .Nitrate and ammoniacal nitrogen can be toxic to aquatic life. We classified river water quality : nitrogen as a case study (Larned *et al.*, 2017) .

Total nitrogen involved the previous illustrated inorganic nitrogenous compounds (ammonium ion NH_3, active nitrite NO2 and active nitrates NO3) and the organic nitrogenous compounds ,organic nitrogenous compounds include such natural materials as proteins and peptides , nucleic acids and urea, and numerous synthetic organic materials . Typical organic nitrogen concentrations vary from a few hundred micrograms per liter in some lakes to more than 20 mg/l in raw sewage (APHA,1999) . Due to the increase in the pollution of nitrogen compounds in natural water for several reasons, including excessive use of mineral fertilizers in excess of the need of plants as well as not observe the ideal period of fertilization as well as imbalance between the number of pets and the area of land on which the breeding of these animals and depletion of the amount of humus produced from waste These animals will plow pasture and accelerate aerobic processes leading to nitrogen mineralization and accelerate the nitrification in water medicine Consciousness and raise the concentration of oxygen in the water drainage play as increased washing of nitrate from the root zone of the soil process resulting from Perfusion excess land (Al-Aji, 2015).

Phosphorus (P) is a nutrient essential for living being, in the other aspect excessive input of P into lakes, reservoirs, rivers, and coastal waters often results in Eutrophication (Correll & David, 1998; Tang et al., 2014; Wu *et al*., 2016). Eutrophication will cause opposite effects to the aquatic system, such as algal blooms, destruction of aquatic habitats, changes in the optic character of water, oxygen deficiencies, and loss of income in recreation-based economies. The eutrophication of coastal waters is recognized as one of the most common impacts of human activity and coastal development (Smith *et al*., 2011; J. Wang *et al*., 2015).

The ultimate supply of (P) to the water is controlled by tectonics and subsequent weathering of continental rocks (Karl, 2014). However, with the development of industrialization, the anthropogenic inputs, including agricultural runoff and urban domestic and industrial effluent, have the major impact to the water nutrient loads and accelerate the trophic process (Nürnberg, 2009; Seitzinger *et al*., 2010). Much effort has been made to reduce external nutrient loading and control eutrophication. However, reduction of external nutrient loading does not always lead to a low nutrient content.

Nitrogen and phosphorus that accumulated in sediment during the high loading periods needs to reach a new dynamic equilibrium under the new loading level, and this process could take a long time (Søndergaard *et al*., 2003).

Past re-search shows that (P) would be released into the overlying water from the sediment continuously, leading to eutrophication (Wang *et al*., 2013; Xu *et al*., 2015; Y. Zhang *et al*., 2016). During eutrophication, Bio-geochemical feedbacks in sediment can increase the availability of both (N) and (P) (Howarth *et al.,* 2011). Various (P) fractions in sediment have various bioavailability and exchangeability, and most of them absorbed in to the riverbed or within Iron, Manganese, Aluminum, and Calcium oxides and hydro-oxides (Z. Wang *et al*., 2015; W. Zhang *et al*., 2016) .

Sediment plays an important role in P cycling, it can release P to the overlying water and adsorb (P) from it simultaneously (Ahlgren *et al*., 2011). A dynamic equilibrium of (P) adsorption-desorption exists between sediment and the overlying water (Boström *et al*., 1988a, 1988b; Chen *et a*l., 2016). If adsorption intensity is higher than release intensity, the concentration of P in the overlying water will be reduced. If the adsorption intensity is lower than the release intensity, the sediment will be at risk of releasing (P). This means that the sediment has a double effect on the (P) content of the overlying water.The dynamic equilibrium between water and sediment determines primary production and the occurrence of algal blooms (Roy *et al.,* 2011) .

Material and Methods:

Water samples collection:

Fourteen location have been selected starting from the Shilha location north of Al-Haritha to Al-Bahadriyah location north of Abu Al-Khasib along middle part of Shatt Al-Arab River, figure(1) coordinates are in table 1. The samples were collected at the depth of around 20 -30 cm below the water surface in the mid of river width, whenever it was possible. Samples were taken in good weather condition with no rain. At each station about 10 liter were collected directly by polyethylene containers after washing these containers with sample water (for water quality analysis purpose) and stored in ice box for further analysis The Water Quality Monitor W-2030, manufactured by Horiba, was used to measure pH, Electrical Conductivity, Salinity, Dissolved Oxygen and Turbidity in the field directly. Winkler bottles method were used to detect the dissolved oxygen level and the BOD5 values .

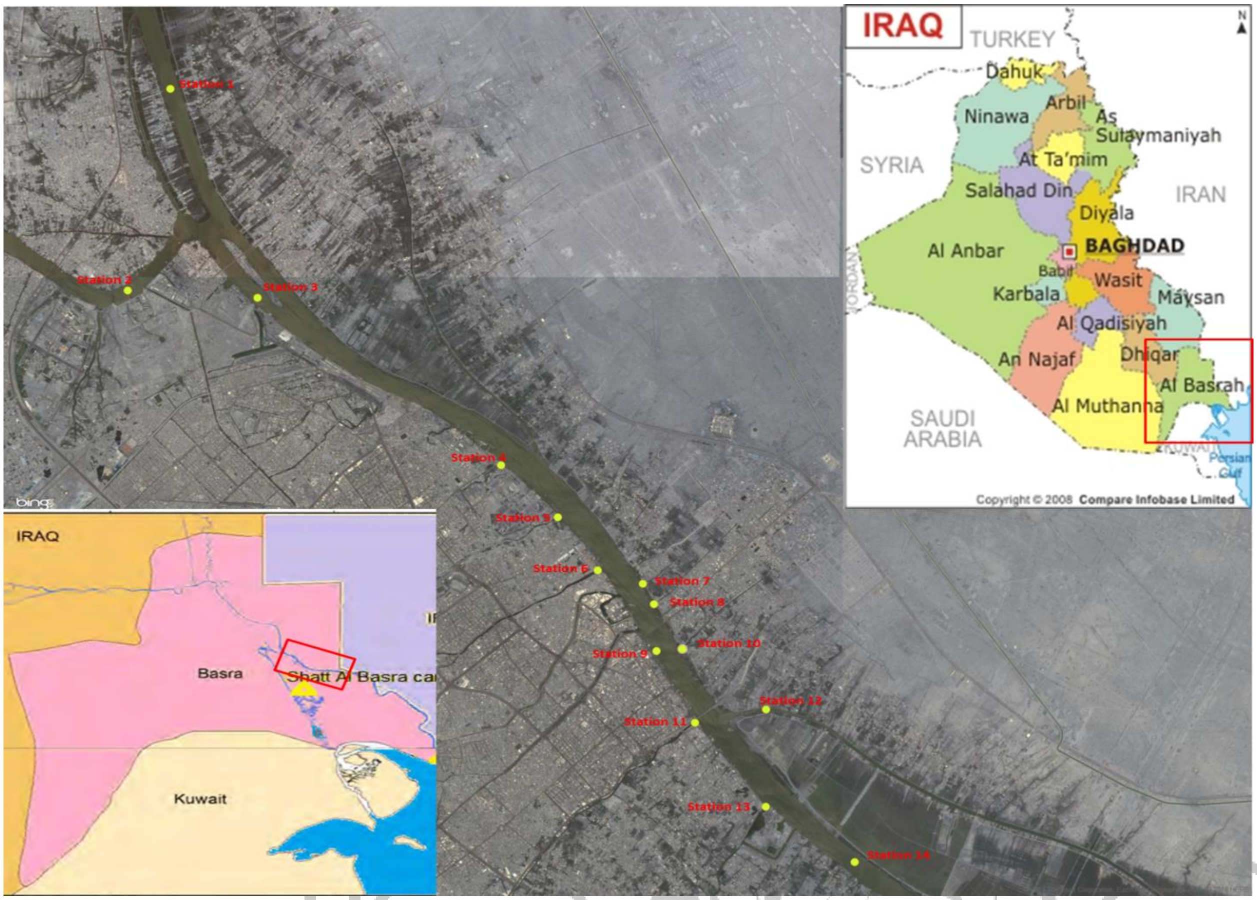


Fig (1): The study stations .

Table 1. Sampling sites, symbol and coordinates

Location	Symbol	Latitude	Longitude
Shahla	SAR1	30 36 02.4N	47 45 56.6E
Karma	KRM	30 34 19.1N	47 45 29.6E
Maqil	SAR2	30 33 59.8N	47 47 11.0E
Jubila	JUB	30 32 48.0N	47 49 08.0E
Rbat	RBA	30 32 20.0N	47 49 39.6E
Srdah	SRD	30 31 53.8N	47 50 26.7E
Chabi	CHA	30 31 35.8N	47 50 38.0E
Tanumh	TAN	30 32 060N	47 50 16.0E
Shyratun	SAR3	30 31 12.2N	47 50 39.6E
Hwamd	HWA	30 32 13.1N	47 50 54.8E
Khora	KHO	30 30 33.3N	47 50 00.6 E
Salhia	SAL	30 30 38.7N	47 51 30.4E
Sraji	SRG	30 29 50.3N	47 51 43.3E
Bhadrya	SAR4	30 29 37.6N	47 52 10.5E

The laboratory works and analyses have been done according to APHA, 2005. Table 2 shows the analytical methods and methods number for studied parameters.

Table 2. Analytical methods for water samples

S. No.	Constituents	Method	Method No.
1	E.C.	Electrical conductivity meter	2510 B
2	Ph	pH meter	4500 H
3	Turbidity	Water Quality Monitor	2130 B
4	D.O	Winkler bottles method	4500-O C
5	BOD_5	Winkler bottles method	5210 B
6	Salinity	Water Quality Monitor	2520 B
7	TSS	Total Suspended Solid at 103-105 C^0	2450 D
8	TP- PO^{-3}_4	Ascorbic acid Method	4500-P B
9	NO_2- NO_3	Nitrate Electrode Method	4500-NO_3 D
10	TN	Micro Kjeldhal Nitrogen Method	4500-N B

The total load of nutrients (L_i) was calculated as:

$$L_i = C_i \,.\, Q_i \,.\Delta t_i$$

Where (Q_i): The flow, Δt_i The time interval and (C_i) is concentration of nutrient (i)

The discharge of the studied rivers an branches was shown in table (3) .

Table (3) The discharges of Shatt al - Arab stations in the study period.

Evening	Morning	Winter	Summer	Periods Of Study
Discharge m^3/Sec				Sampling
11.3	11.1	12.3	18.3	Sample 1
10.5	10.8	11.7	17.8	Sample 2
11.4	11.4	12.2	18.1	Sample 3
11.0	10.9	11.6	17.6	Sample 4

Results and Discussion:

1- Loads of Nutrient

A pollution load is the mass or weight of pollutant transported from a specified unit of area in a period of time, which passes an outlet point (Richards, 1997) .

In general the loads were in the following trend

TN > NO3 > NO2 > TP > PO_4,

for summer TN > TP > NO3 > NO2 > PO_4 ,

for winter the trend was TN > NO3 > NO2 > TP > PO_4

for morning TN > NO3 = NO2 > TP > PO4, and

for evening the trend was TN > NO3 > NO2 > TP > PO_4 .

where it was found that the TN is the highest load and the PO_4 was the lowest load in general at winter, evening and summer, while NO_3 load was equal to NO_2 load during morning .

Nitrogen Loads

Fig.(2.A) shows the values of nitrite load of the different studied station. The highest value was 10 kg/day in both SAR2 and SAR3 at winter. The lowest load was 2.58 kg/day at SAR1 during the evening, while at summer and evening, the loads increased but during winter and morning the load decreased .

The results showed the value of 5 kg/day for input was increased up to 5.15 kg/day in the first section(SAR2-SAR3), the value increased to twice as much as 10 kg/day and then decreased again in the last section (SAR3 – SAR4) 4.68 kg/day at winter, loads increased in the first subsection 10 kg/day did not change the subsection second recorded the same value of 10 kg /day in the last subsection has decreased significantly, reaching 3.23 kg/day, at morning has increased the in the first subsection, 3.56 kg /day, as well as in the second subsection, increased 4.18 kg/day. In the last subsection, the value decreased 2.61 kg/day. In the evening, the load in the first subsection increased 2.78 kg/day, There was an increase of 3.19 kg /day in the last subsection, the value decreased to 3.03 kg /day .While for nitrate load the highest values 28 kg /day at winter in SAR3 and the lowest 1.7 kg /day at the SAR2 Fig.(2.B) .At summer, winter and morning the load decreased, at evening loads increased.

The results showed at summer in the first subsection (SAR1 – SAR2) the value increased 8 kg /day, while in the second subsection (SAR2 – SAR3) also increased to 15 kg /day and then decreased again in the last subsection (SAR3 – SAR4) 6 kg /day, during the winter has increased in the first subsection 18 kg /day and also increase in subsecond section 28 kg /day in the last subsection has decreased was 14 kg /day, at morning reduced at first subsection 16 kg /day, as well as decreased in the second and the last subsection 13,11 kg /day respectively, either at evening loads in the first subsection was 1.7 kg /day recorded and it was increased 3 and 6 kg /day in secound and last subsection, respectively.

The highest value of the total nitrogen loads (39 kg /day) was found at the SAR3, winter season (Figure 2.C) and the lowest load (4.5 kg /day) at SAR2 evening time. During summer the input load (at SAR1) was 13 kg /day but outlet load (at SAR4) was 11 kg /day. while in winter, input load 22 kg /day and outlet load 17 kg /day. In the evening, the input load was 5 kg /day while the outlet loads 9 kg /day, either at morning, input load was 25 kg /day while the outlet 17 kg /day.

The results in the first subsection (SAR1 – SAR2) showed increasing in the load from

13 to 14 kg /day, while in the second subsection (SAR2 – SAR3) the load increased significantly, reaching 26 kg /day and then decreased significantly in the last subsection (SAR3 – SAR4) about 15 kg /day. At winter has increased in the first section from 22 to 28 kg /day but it was increased in second subsection up to 39 kg /day while at last subsection has decreased to 17 kg /day.In the morning time the loads has decreased in all substations from 25, 20,17,14 kg /day, respectively, while at evening the loads decreased 4 kg /day in the first subsection and it was increased 6 and 9 kg /day in second and last subsection, respectively.

The results nitrate, nitrite and total nitrate loads showed a highest values at winter in SAR3 due to low consumption of these nutrients due to low activity of low temperature (Varol *et al.,* 2011). The decline in values during the evening may be due to the decrease in the imports of sub-rivers due to the lack of various human activities at this time of day.

The results also showed that during the comparison of the input with the outlet of nitrite during the summer and the morning period due to the quantities of nutrients coming from the sub-rivers, while the decrease in values during the winter and the evening due to the lack of activities and human activities may be due to high values of nitrates and total nitrogen when compared to pregnancy in the evening because of the low efficiency and activity of aquatic plants and phytoplankton, thus increasing the nutrients while the values decreased during the summer and winter and morning period due to the activity of plankton and aquatic plants .

The results also showed that the increase nutrient load at first subsection (SAR1 – SAR2) and the second subsection (SAR2 – SAR3) during the summer and winter due to the impact of contaminants and the damage of the side rivers between them .

Phosphate loads

Figure (2.D) shows the reactive phosphate loads, the highest value was 0.326 kg /day recorded in SAR4 at evening , while the lowest value 0.04 kg /day was at SAR1. For summer period, the reactive phosphate input load (SAR1) was 0.209 kg /day and reactive phosphate loads at outlet (SAR4) was 0.230 kg /day, but at winter the loads decrease comparing to summer period, it was recorded 0.119 kg /day at input and 0.046 kg /day at outlet location. The input load at evening time was 0.127 kg /day but for the outlet was 0.326 kg /day. While for morning, the input load was 0.122 kg /day and the outlet load was 0.125 kg /day.

During summer period , the results showed that the loads crossing the subsection one (SAR2) was decreased the it was recorded 0.182 kg /day. In the second subsection, the values increased 0.188, 0.230 kg /day respectively. At winter, the loads crossing the first subsections 0.119 to 0.179. 0.198 kg /day, and for the second increased to 0.198 kg /day. In the last sub section, the load was 0.046 kg /day.

The reactive phosphate load during the morning at crossing point of first subsection and the second subsection was recorded to the level of 0.137, 0.178 kg /day and for the last subsection dropped to 0.125 kg /day. But for evening the load crossing the first subsection was increased to 0.148 kg /day, while it was decreased to 0.127 kg /day in the second crossing point, in the last point increased significantly to 0.326 kg /day.

The total phosphorus loads (Fig. 2. E) the output location (SAR4) exhibited the highest load 11 kg/ day at the summer season, the lowest load 0.21 kg /day at evening .

The studied section of Shatt Al-Arab at summer period was lost about 6 kg /day, while during the winter about 0.006 kg/day was consumed in this river section. During evening period , the input load was 0.925 kg /day while the outlet load was 1.233 kg /day and for the morning, the input load was 2.513 kg /day the outlet 1.385 kg /day.

The results were showed that the load during the summer increase at all location, reaching 7,10,11 kg /day respectively, either at winter the crossing load the first subsection (0.549 kg /day) has increased comparing the input load but for morning period, was reduced in the first and second subsection, it was 0.972, 0.212 kg /day respectively, at last subsection, the load increased up to 1.385 kg /day. At evening, the loads was dropped at passing first section to 0.196 kg /day comparing to input load, either in the second and last subsection has values reaching 0.795, 1.233 kg /day, respectively.

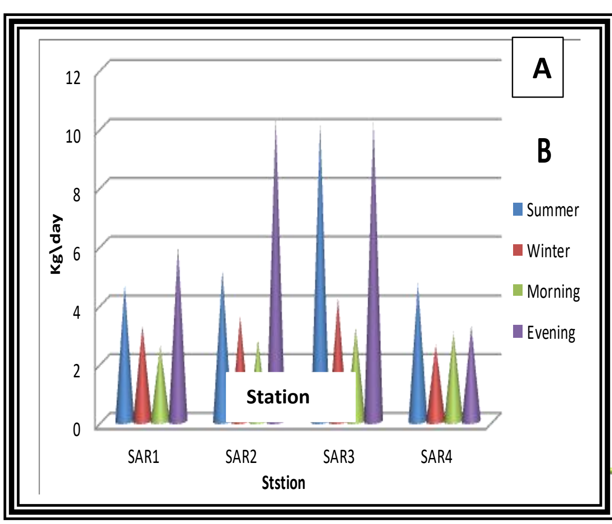
The results of effective phosphate and phosphorus loading showed that the high values during the summer due to the increase in human activities and discharges of sewage water. The decline in values at winter and the evening period is due to the lack of sub-river imports due to the lack of various human, industrial and agricultural activities, and sewage water, and sedimentation to the bottom .

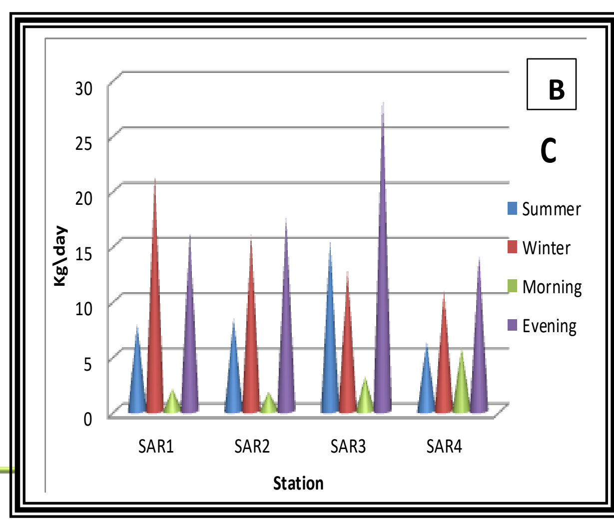
The results showed that during the comparison of input with the outlet the decrease during the winter, due to the lack of activity and effectiveness of the living and also the result of sedimentation may be due to high values during the summer to increase the water from the side rivers loaded with many Phosphate compounds.

And the results showed also when comparing the sections of the area studied that the increase in all subsections during the summer due to increased activity and activities of living and humans may be due to increased load at first subsection (SAR1-SAR2) and the second subsection (SAR2-SAR3) during the winter to the lack of activity of organisms, while the reason for the high values in the third subsection (SAR3- SAR4) during the evening as a result of reduced activity neighbourhoods .

/day in the evening. For the branches with low discharge, during summer the highest value of 0.142 kg / day in the (Sal) River and the lowest value of 0.029 kg /day in the Jubila River. While during winter the highest value was 0.485 kg / day in the (SRD) and the lowest 0.002 kg / day in the Jubila River. At morning time the highest value was 0.143 kg /day in (KHO) and the lowest 0.022 kg /day in (JUB). At evening, the highest value was 0.124 kg /day in (KHO) while the lowest value was 0.035 kg /day in (JUB) river .

Figure (3) show the nitrite load for the different study stations. The results showed that the highest value 3.753 kg /day during winter in Karma river due to high discharge of the channel, the lowest value 1.301 Kg





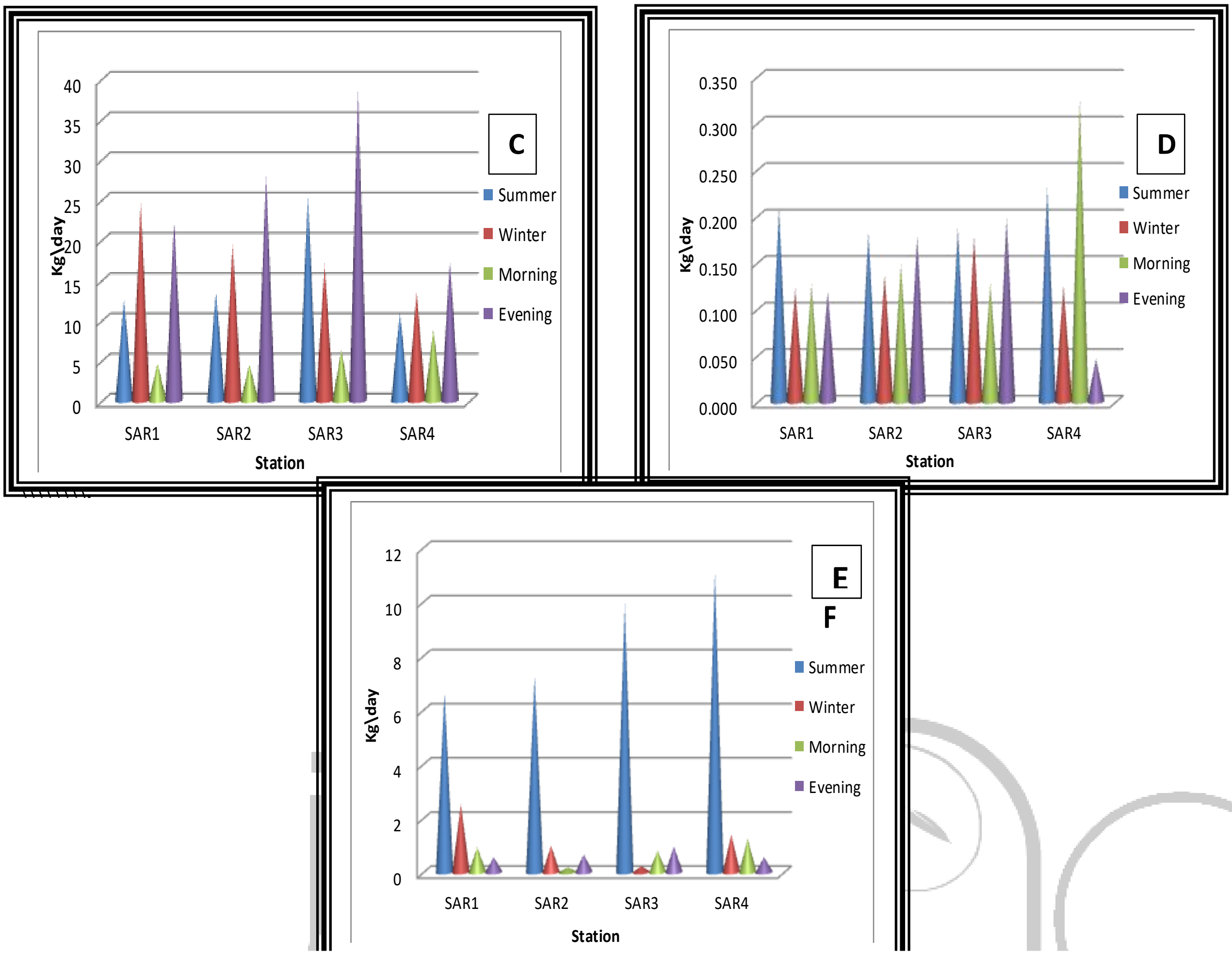


Fig.(2): Change with the course of the Shatt al – Arab as (kg/day) at the studied stations
(A) Nitrite concentration (B) Nitrate concentration (C) Total Nitrogen (D) Reactive Phosphate (E) Total Phosphate
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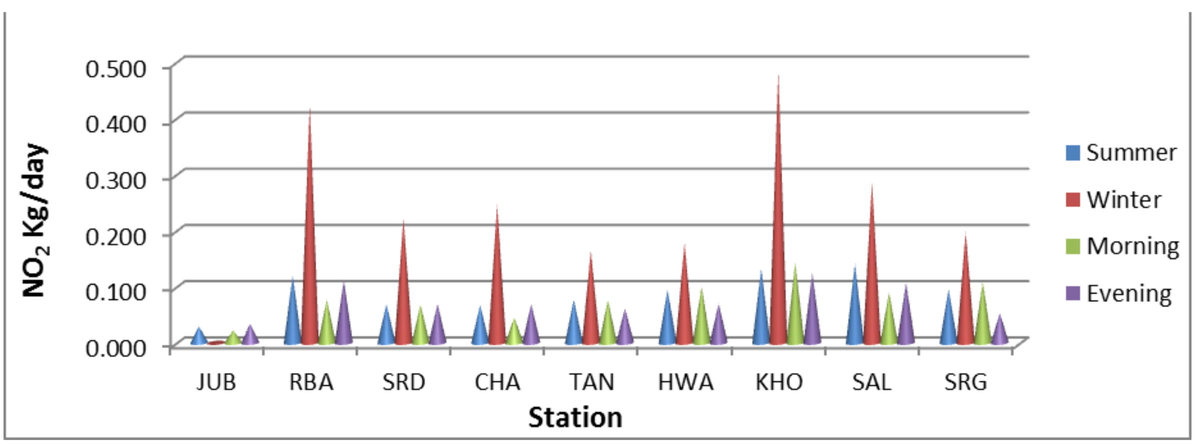

Fig.(3): Nitrite(NO^{2-}) as (kg/day) at the studied stations .

While for nitrate load the highest value 7.886 kg /day during the winter in (KRM) due to high discharge of the channel, the lowest value 0.544 kg /day in the morning figure (4). For the branches with low discharge, during summer the highest value was 0.266 kg /day in (SAL) and the lowest value of 0.031 kg /day in (JUB) river. While at winter the highest value of 0.708 kg /day in (KHO) and the lowest value of 0.039 kg /day at(JUB) River. At morning time, the highest value was 0.062 kg /day in (KHO) and the lowest value was 0.004 kg /day in (JUB). During evening the highest value 0.100 kg /day in (KHO) while the lowest value of 0.034 kg /day in (SRG) .

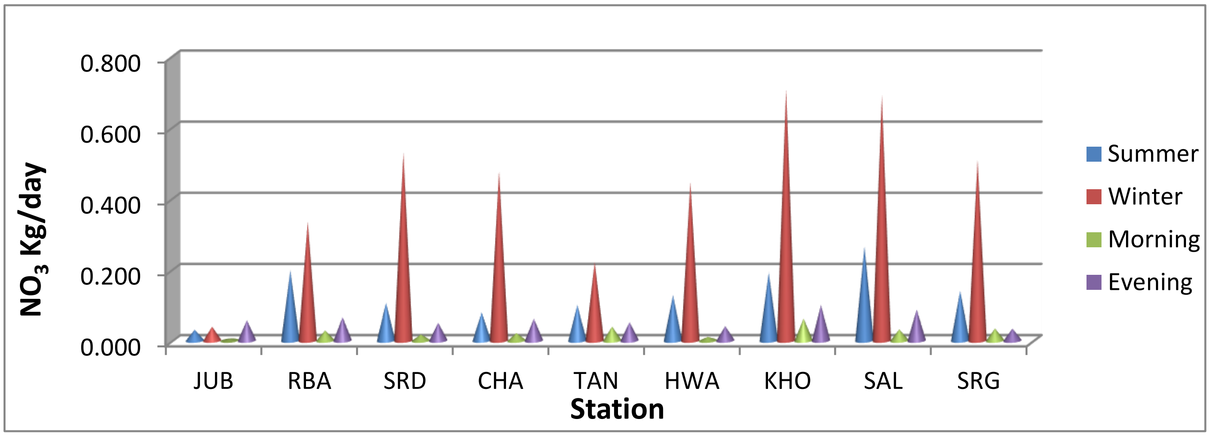

Fig.(4): Nitrate(NO_3^-) as (kg/day) at the studied stations.

The total nitrogen loads (Figure 5) the station exhibited the highest value 11.639 kg /day at morning in karma river due to high discharge of the channel, the lowest value 2.262 kg / day during the winter. For the branches with low discharge, During the summer the highest value 0.407 kg/ day in (SAL) and the lowest value 0.060 kg /day in (JUB). While at winter, the highest value 0.224 kg /day in (KHO) and the lowest value 0.087 kg /day in (SRG). At morning time, reaching the highest value 1.193 kg /day in (KHO) and the lowest value 0.041 kg /day in (JUB) . At evening, reaching the highest value 0.893 kg /day in (SAL) while the lowest value is 0.192 kg /day in (JUB) .

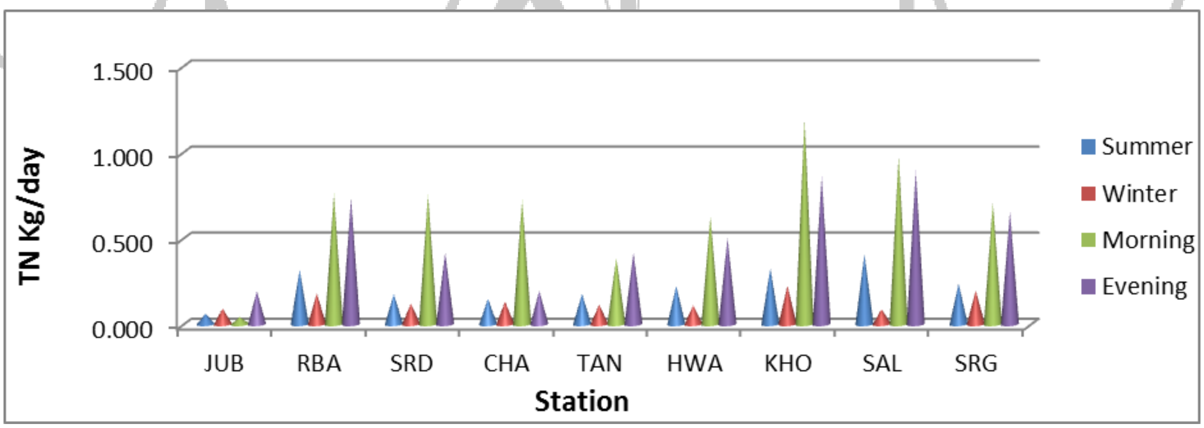

Fig.(5): Total Nitrogen (TN) as (kg/day) at the studied stations .

Figure (6) shows the reactive phosphate load of all the study stations. The results showed that the highest value 0.240 kg / day during the winter in karma river due to high discharge of the channel, the lowest value 0.082 kg / day at evening. For the branches with low discharge, During the summer, the highest value was 0.005 kg /day in (KHO) River and the lowest value 0.001 kg /day in (JUB). At winter, the highest value 0.010 kg /day in (RBA) and the lowest value 0.002 kg /day in (CHA). At morning time, the highest value was 0.006 kg /day in

(RBA) River and the lowest value 0.001 kg /day in (JUB) River . Either at evening the highest value was 0.004 kg /day in Rbat river while the lowest value was 0.001 kg /day in Jubila River .

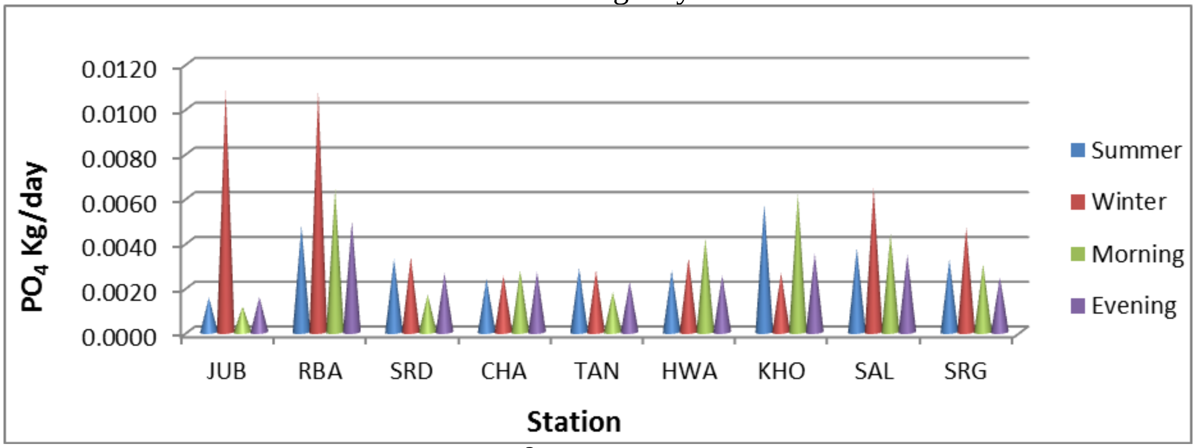

Fig.(6): Reactive Phosphate (PO_4^{-3}) as (kg/day) at the studied stations .

For the total phosphorus load the highest value 3.273 kg /day during the summer in karma river due to high discharge of the channel, the lowest value 0.418 kg /day during the winter figure (7). For the branches with low discharge, During the summer, the highest value was 0.293 kg /day in (SAL) and the lowest value 0.043 kg /day in (SRD). At winter, the highest value 0.025 kg /day in (SAL) and (HWA) and the lowest value 0.010 kg /day in (JUB). While at morning time the highest value was 0.107 kg /day at (RBA) River and the lowest value 0.010 kg /day in (SAL) and (HWA) rivers . At evening, the highest value was 0.062 kg /day in (KHO) while the lowest value was 0.004 kg /day in (JUB) .

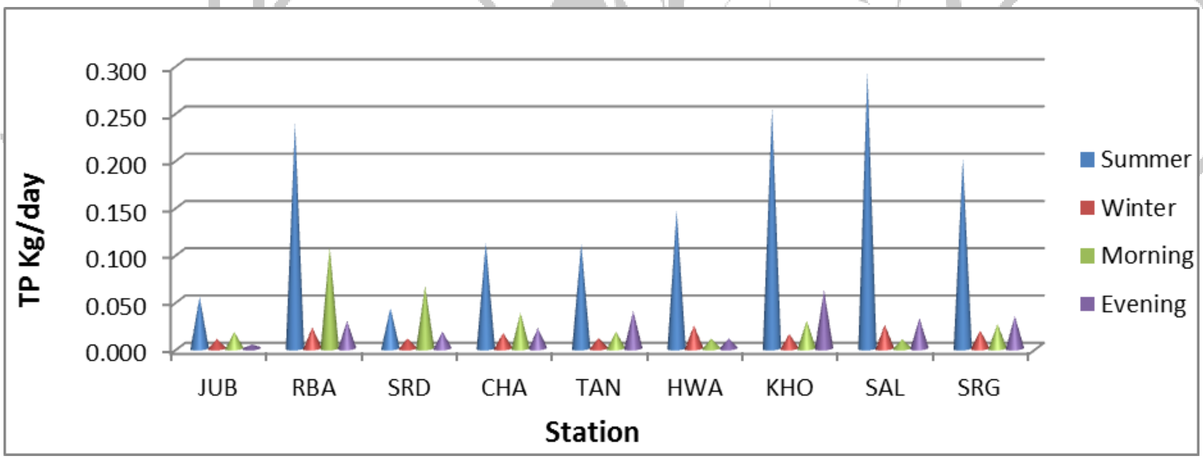

Fig.(7): Total Phosphate (TP) as (kg/day) at the studied stations .

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