# Changes in Some of Heavy Elements Concentrations and Their Relationship with Some Environmental Factors in The Iraqi Coastal Water

B.A. Al abdulaziz *, M. F. Abbas, F. J. Al-Imarah

Marine Science Centre, University of Basrah, Basrah – Iraq.

*Corresponding author E-mail: **alabdulazizbassam@gmail.com**

## Abstract

Five environmental factors were recorded in the areas near Basra oil port and near Buoy 17 in addition to the Umm Qasr Port. The three locations that are concerned within this study represent sites of movement of steamers and oil tankers. Where the monthly study was conducted on the changes occurring in the Electrical conductivity, water temperature, pH, turbidity and total dissolved solid. The current study indicated that the temperature values were within their annual rates as they ranged from 14-34 °C and the values of pH were that within the ranges prevailing characteristic of Iraqi coastal waters, while Electrical conductivity recorded low values during January in all study stations. Moreover, the turbidity and TDS have low values and high values were recorded in the first and second stations. The relation between those factors with four heavy metals Fe,Cd.pb and Zn was studied. This study is considered as a data base involving the many different parameters and alterable changes in the Iraqi marine waters, hence, it contains essential information which can be used for comparison in case of extension of salt tide to Shatt Al -Arab river.

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## 1. Introduction

A region of sheltered waters is home to a variety of marine, freshwater, and terrestrial ecosystems that interact and mix together. The richness in environmental niches is largely due to the high salinity and nutrient gradients created by mixing freshwater and saltwater.[1]. The water quality of Khor Abdullah is deteriorated due to modernization and industrialization as well as trading activities at Umm Qaser and Khor Al-Zubair ports [2], and it is considered as one of the busiest waterways with the movement of oil and commercial ships as well as ships caring Natural gas [3]. The northern part of the Arabian Gulf concerning the Khor Abdullah area is located in an arid region which characterized by a long and hot summer season with a temperature range between 35 and 50 oC, and winter is quite short with cold and moderate wet climate and a temperature range between 7 and 17 oC. Rainfall is rare and limited[4]. Khor Abdullah and its extended lagoon Khor Al-Zubair to the north are part of the Iraqi marine water situated at the Northwest of the Arabian Gulf. Their importance lies in economical, industrial, fisheries as well as oil transportation, and their quality is a reflection of Iraqi marshes as they extended to Hor Al-Hammar Through Shatt Al-Basrah Channel. Moreover, water characterization of Khor Abdullah and Khr Al-Zubair is effected by the tidal phenomena of the Arabian Gulf. [5].Several studies were conducted in the field of marine chemistry in the Iraqi coast and the Arabian Gulf [6].This study aims to determine the long-term variation in concentrations of four heavy metals on a basis of seasonal variation at selected monitoring stations in the water environment in Southern Iraq.

## 2 Materials and Methods

### 2.1 Study Area

Khor Abdullah is situated in the northwestern part of the Arabian Gulf. It is a shallow water body with a depth range from 7 – 14 m and a length of 40 km from its northern part at the end of Khor Al-Zubair close to Umm Qaser town. The water quality of Khor Abdullah is characterized by certain physical, chemical, biological and radiation properties which are affected by industrial and domestic wastes as well as fishing and water discharges**.** Three monitoring stations along Khor Abdullah navigational channel were selected for this study (Fig. .1), Station 1 is located close to Umm Qaser port and has the coordinates, E 47° 55′ 14.7″، N 30° 06′ 47.3″. It has depth range 12-14 m and effected by high currents for high and low tides. Station 2, located within the navigational channel close to boye 17 with E 48° 19′ 48.9″، N 29° 53′ 26.2″, it is characterized by

depth range of 10-13 m and high turbidity due to the currents of high and low tides. Station 3, located close to Basrah petroleum port in the open marine waters with coordinates of E 48° 47′ 22.1″، N 29° 37′ 49.1″ it is characterized by low turbidity compared to other stations and water depth range 10-30 m. The samples were collected monthly from three stations for the period from February 2018 to January 2019 at a depth of 10-20 centimeters below the surface of the water by means of a plastic container.

## 2.2 Sampling

Water samples were collected monthly, from the three selected stations for the period February 2018 to January 2019 , and adopting the following methodology, pH, Electrical conductivity, salinity, and TDS were measured in the field by using calibrated portable instruments. While Fe, Cd, Pb and Zn which are considered as chemical parameters were measured in the lab according to standard methods [7]. Water samples were taken below the surface of the water at a depth of 10-20 centimeters by a plastic container and a medium-sized marine tug was used in the collection of samples. A US-made HORIBA U-5030 multimeter was used to measure water temperature, pH, electrical conductivity and total dissolved solids. The turbidity was measured using the Turbidimette LaMotte2020we type and was expressed in units NTU.

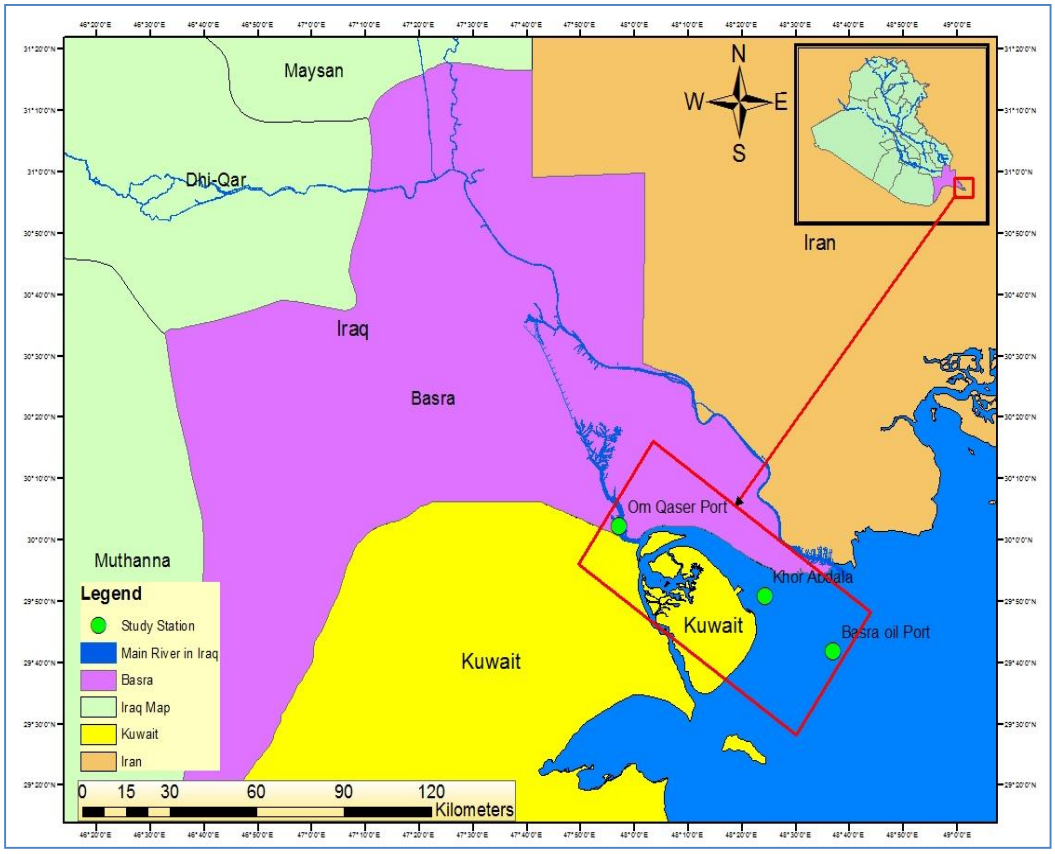


Fig. 1: Map of Southern part of Iraq showing the locations of sampling stations.

### 2.3 Measurements

Temperature, pH, Turbidity, and EC were measurements in situ which temperature in oC was measured by digital thermometer with a range of 0-100˚C graduate at 0.2˚C, pH was measured using pH meters model HANNA HI-9821,and Electrical Conductivity (EC in µS/cm) was measured using portable digital conductivity meters (WTW 3301), and turbidity (in NTU) was measured by WTW portable turbidity meter TURB355IR/T .sTo complete measurements , chemical parameters were measured in the lab according to standard methods [7], In which TDS(mg/l) measured using gravimetric method to APHA,2012 heavy metals was determine using Atomic Absorption spectrophotometer(AAS) Type GBC Savant AA atomic absorption .

## 3 Results and discussion

There was Non-significant differences between the levels of measured parameters in the three selected stations within this study, with few exceptions, due to the similarities of the atmospheric conditions as well as the source of water [8] .

### 3.1 Water Temperature

Water temperatures were ranged between lower levels around 14$^{o}$C at stations 1 and 2 during Jan. 2019 and higher levels around 34oC at station 3 during August 2018 as listed in table 1 and shown in figure 2. Seasonally, water temperatures were higher during summer, and lower at winter[as shown in table 2 as a reflection of air temperature and values recorded comparable to Shatt Al-Arab river for the range 12-39oC. Due to daytime variations of water temperature is expected. The results of the statistical analysis showed that there were no significant differences ($p>0.05$) between the study stations.

Table 1: Monthly variations of water temperature in the three sites of study.

| **12** | Feb. | March | April | May | June | July | Aug | Sep | Oct | Nov | Dec | Janu. | Lower | Upper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 16.2 | 19.5 | 23 | 26.1 | 27.9 | 30.07 | 31 | 31 | 31 | 24.8 | 20.5 | 14 | 14 | 31 |
| **2** | 16.7 | 21.6 | 22.6 | 25.6 | 29.4 | 30.9 | 31 | 31 | 30.5 | 23.5 | 19.5 | 14 | 14 | 31 |
| **3** | 17.3 | 19.5 | 24 | 27 | 29 | 31.7 | 34 | 33 | 30 | 26 | 21 | 15 | 15 | 34 |

Table 2: Seasonal variations for water temperature in the three stations of study.

| Season→<br>Station↓ | Winter | Spring | Summer | Autumn | Lower | Upper |
|---|---|---|---|---|---|---|
| 1 | 16.9 | 22.9 | 29.5 | 28.9 | 16.9 | 29.5 |
| 2 | 16.7 | 23.3 | 30.4 | 28.3 | 16.7 | 30.4 |
| 3 | 17.8 | 23.5 | 30.9 | 31.0 | 17.8 | 31.0 |

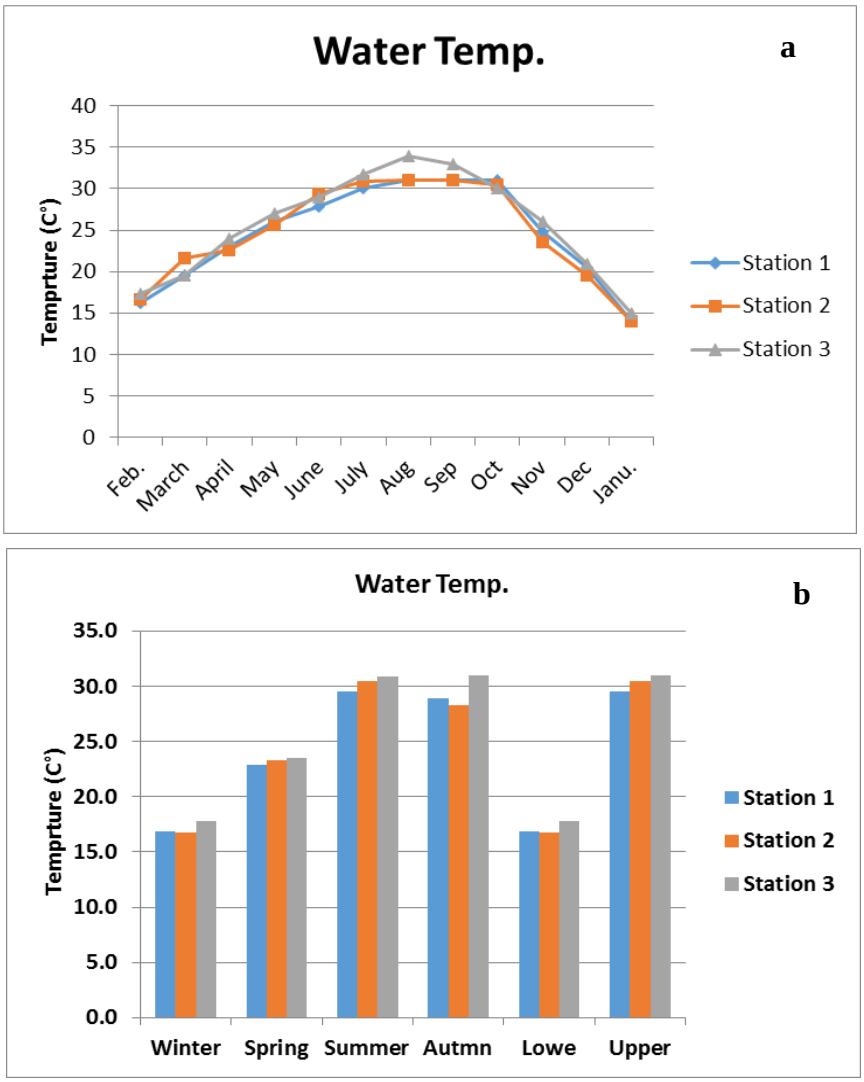


Fig. 2: Variations of water temperature for the study stations, (a) monthly basis and (b) seasonal basis.

### 3.2 Hydrogen Ion Concentration (pH)

The pH represents the measurement of Potential of Hydrogen ions in solution, values recorded range between higher value of 8.5 at station 3 during Feb. and lowest of 7.6 at station 3 during May, as shown in table 3. These values are comparable to those reported in Shatt Al-Arab river which ranged 7.56 – 7.84 [9]. pH values are affected by water balance of CO2, CO3-2 and HCO3- . Recorded pH values in Khor Abdullah are comparable to those reported in waters of the middle sector of Shatt Al-Arab river which was ranged 7.4-8.52 [10] . Seasonal variation , table 4, did not show great differences among seasons in all studied sites and values recorded did not exceed the values provided by WHO guide-lines of 6.5–8.5 [10]. Variations as Monthly variations and seasonally variations in pH of water are shown in figure 3, a and b respectively. The results of the statistical analysis showed that there were no significant differences ($p>0.05$) between the study stations.

Table 3: Monthly variations of pH in the three sites of study.

| month→ Station↓ | Feb. | March | April | May | June | July | Aug | Sep | Oct | Nov | Dec | Janu. | Lower | Upper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.4 | 8.49 | 7.8 | 7.7 | 7.73 | 8.3 | 8.2 | 8.3 | 8.2 | 8.2 | 8.1 | 8.14 | 7.70 | 8.49 |
| 2 | 8.2 | 8.45 | 7.9 | 7.9 | 8.47 | 8.3 | 8.1 | 8.1 | 8.1 | 8.2 | 8 | 8.1 | 7.90 | 8.47 |
| 3 | 8.5 | 8.48 | 8.23 | 7.6 | 8.47 | 8.49 | 8.3 | 8.21 | 8.2 | 8.45 | 8.2 | 8.15 | 7.60 | 8.50 |

Table 4: Seasonal variations for pH in the three stations of study.

| pH | Winter | Spring | Summer | Autmn | Lowe | Upper |
|---|---|---|---|---|---|---|
| Station 1 | 8.2 | 8.0 | 8.1 | 8.2 | 8.00 | 8.21 |
| Station 2 | 8.1 | 8.1 | 8.2 | 8.1 | 8.07 | 8.20 |
| Station 3 | 8.3 | 8.1 | 8.4 | 8.3 | 8.10 | 8.42 |

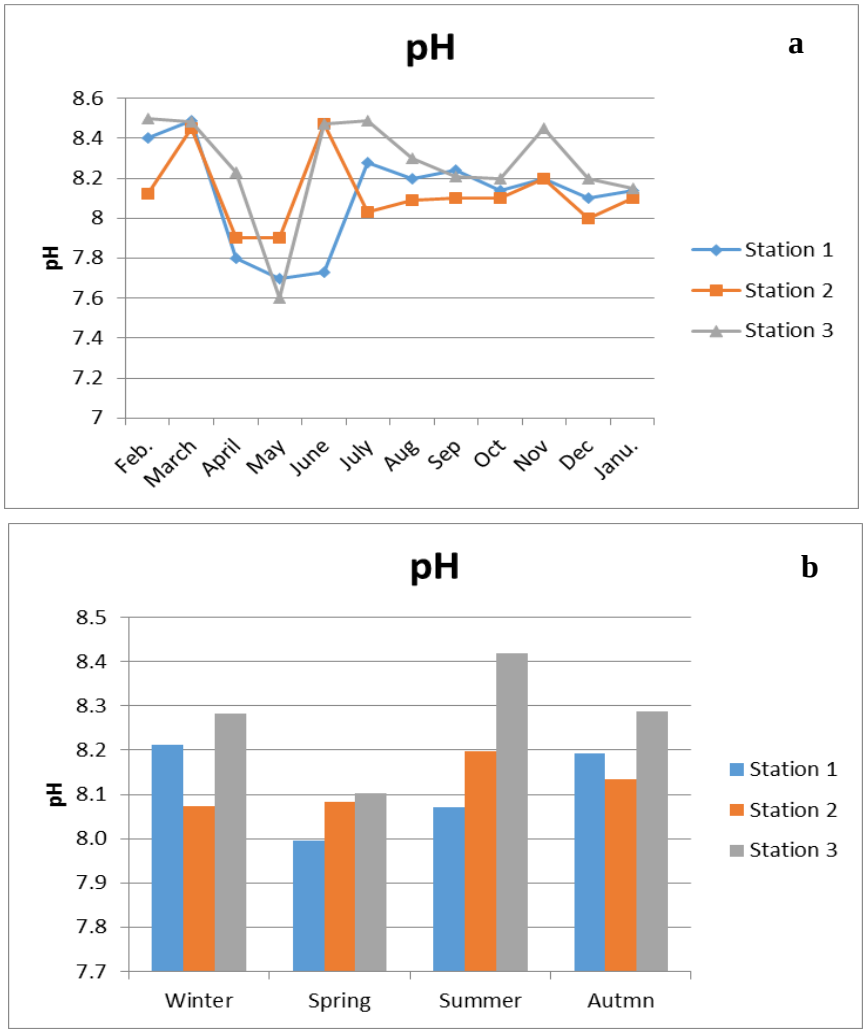


Fig. 3: Variations of pH in the waters of the selected stations within this study (a). monthly basis, (b). seasonal basis

### 3.3 Turbidity (NTU)

The Turbidity values showed different ranges in the three study stations, as their values ranged between 0.64 and 81 NTU. (Figure 4) shows the clear fluctuation in these values during time, as the lowest value of 0.64 NTU was recorded in January at the third station, while the second station recorded a low value of 30.7 NTU during August, and the first station recorded the lowest value of 31.6 NTU in September, and the highest in the three stations 75, 81 and 3 NTU during November, December and August respectively. Statistical analysis showed that there was a significant difference between the third station and others ($p<0.05$), and no differences were

recorded between the station one and two. turbidity are listed in tables 5 and 6 and illustrated in figure 4 .

Table 5: Monthly variations of Turbidity in the three sites of study.

| Turbidity | Feb. | March | April | May | June | July | Aug | Sep | Oct | Nov | Dec | Janu. | Lower | Upper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 1 | 74 | 59.3 | 71 | 65.6 | 41.3 | 35.9 | 33.4 | 31.6 | 37 | 75 | 69.5 | 50.5 | 31.60 | 75.00 |
| Station 2 | 50.1 | 57.7 | 59.9 | 60 | 40.3 | 52 | 30.7 | 55 | 36.1 | 50 | 81 | 40.7 | 30.70 | 81.00 |
| Station 3 | 0.91 | 0.98 | 1.63 | 2.1 | 2.11 | 1.3 | 3 | 1.33 | 2 | 0.99 | 1.48 | 0.64 | 0.64 | 3.00 |

Table 6: Seasonal variations of Turbidity in the three sites of study.

| Turbidity | Winter | Spring | Summer | Autmn | Lowe | Upper |
|---|---|---|---|---|---|---|
| Station 1 | 64.7 | 65.3 | 37 | 48 | 37 | 65 |
| Station 2 | 57 | 59 | 41 | 47 | 41 | 59 |
| Station 3 | 1.01 | 1.6 | 2.1 | 1.4 | 1.01 | 2.1 |

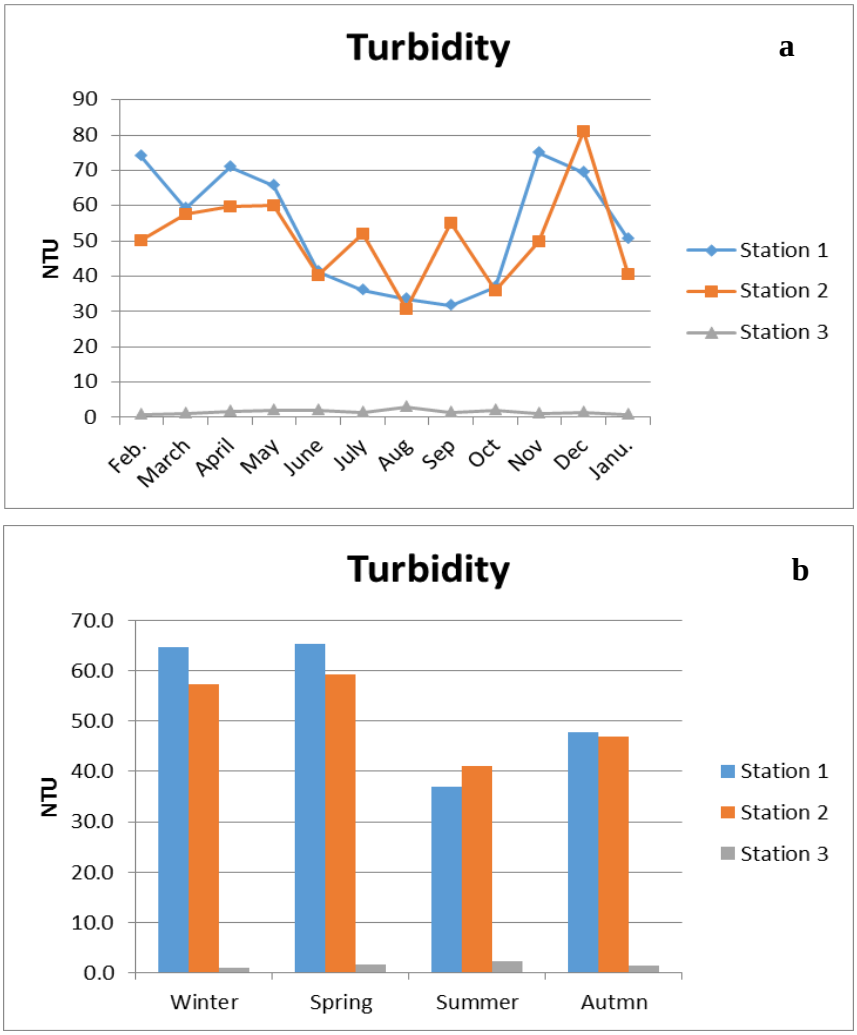


Fig. 4: Variations in Turbidty of the waters from the selected stations within this study (a) monthly basis, (b) seasonal basis

### 3.4 Total Dissolved Solids (TDS)

Total dissolved solids were recorded in stations during January with values of 34.2 and 31.3; 25.3 mg/l, in the three stations respectively, as where higher values of 50 mg/l was recorded in the first station during December and 40.12 and 40 mg/l in the second and third during November and February, respectively (Figure 5). The results of the statistical analysis showed that there were no significant differences ($p>0.05$) between the study stations.

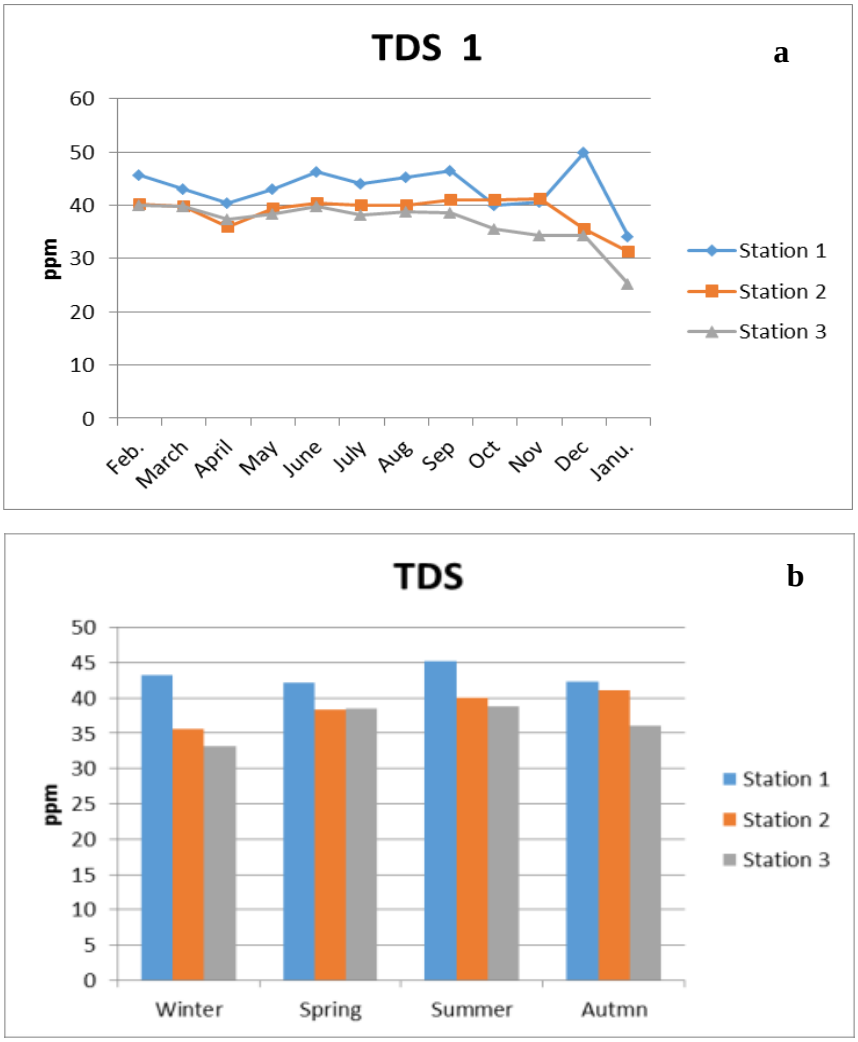


Fig. 5:Variations in TDS of the water from the selected stations within this study (a) monthly basis, and (b) seasonal basis

### 3.5 Electrical Conductivity (ms/cm)

The lowest level of conductivity values were recorded during January with values ranging from 53.4, 48.9 and 45.7 ms/cm at the first, second and third stations, respectively, the highest values were recorded in June in the first station (77.1 ms/cm (Figure 6). The results of the statistical analysis showed that there were no significant differences ($p>0.05$) between the study stations.

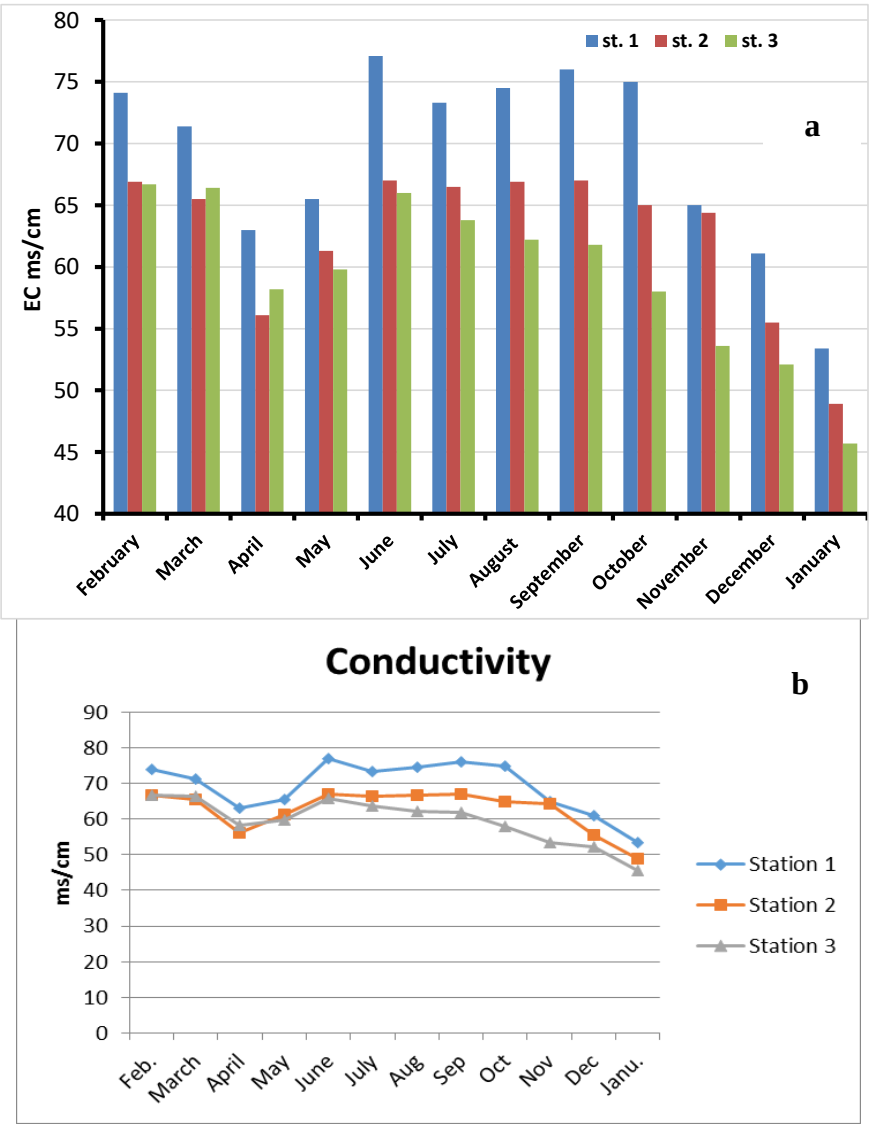


Fig. 6: Monthly variation in the conductivity values at the three stations of the Iraqi marine water during the period from February 2018 to January 2019.

### 3.6 Iron element (Fe mg/l)

The Iron element values ranged between 1.811 and 9.843 mg/l in the first station during December and March, and in the second station they ranged between 0.079 mg/l during January and 6.772 mg/l during May, and in the third station, they ranged 0.0 and 0.472 mg/l during February and January, respectively (Figure 7).

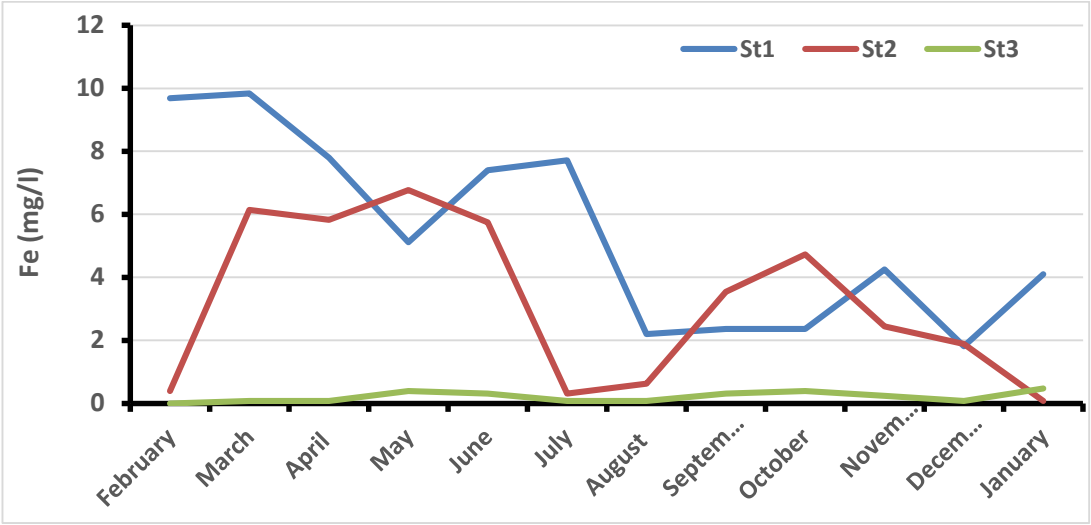


Fig. 7: Monthly variation in the Iron element values at the three stations of the Iraqi marine water during the period from February 2018 to January 2019.

### 3.7 Cadmium element (Cd mg/l)

Figure 8 shows the clear fluctuation in the values of cadmium as a function of time, where the lowest value of 0.0 mg/l was recorded at the second station on April, May and January. Whereas, the third station recorded a low value of 0.0 mg/l during February. Finally ,the first station recorded the lowest value of 0.286 mg/l in July. The highest values in the three stations 0.899, 0.061 and 0.071 mg/l during March where measured at the first station, July and August at the second station and October at the third station respectively. The cause of such fluctuation can be attributed to the decrease of water discharge to the first station.

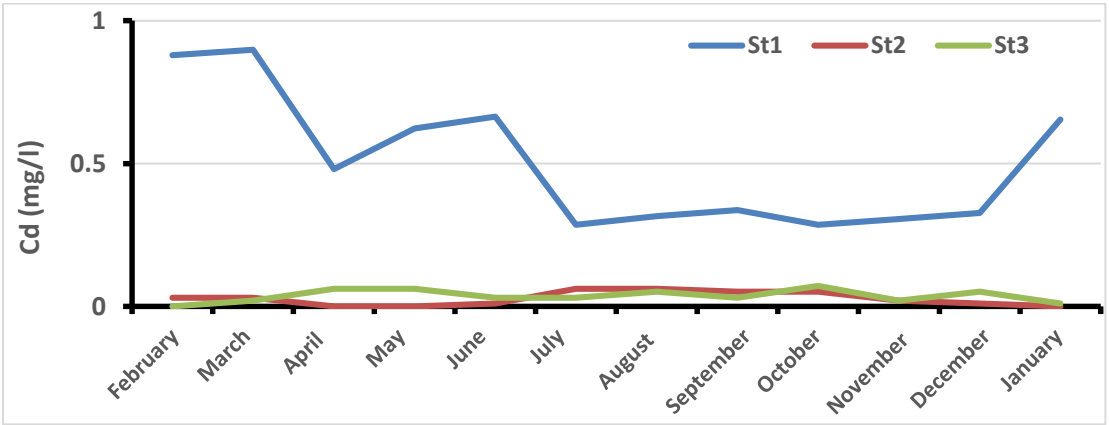


Fig. 8: Monthly variation in the Cadmium element values at the three stations of the Iraqi marine water during the period from February 2018 to January 2019.

### 3.8 Lead element (Pb mg/l)

The lowest values of Lead were recorded 0.0 mg/l level in all study stations, during April, May and December at the first station, such as during March, November and December at the second station, While during June at the first station. shows higher values of 0.575 mg/l were recorded in the first station during June and 0.555 mg/l in the second station during April and 0.666mg/l in the third station during March, respectively (Figure 9).

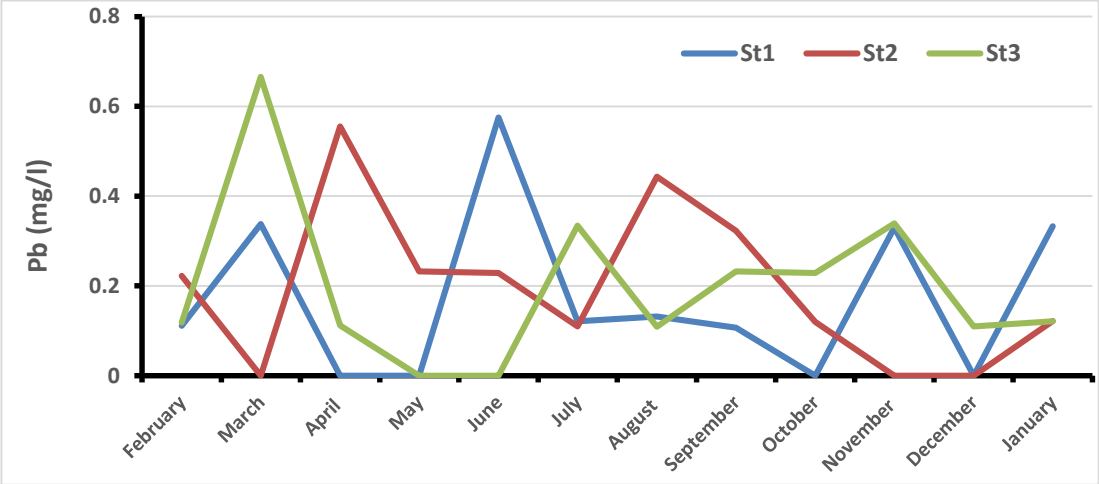


Fig. 9: Monthly variation in the Lead element values at the three stations of the Iraqi marine water during the period from February 2018 to January 2019.

### 3.9 Zinc element (Zn mg/l)

The Zinc element values ranged between 0.010 and 0.276 mg/l in the first station during September and October respectively, and in the second station they ranged between 0.469 mg/l during April and 0.662 mg/l during July, and in the third station, they ranged 0.276 and 0.635 mg/l during April and December, respectively (Figure 10).

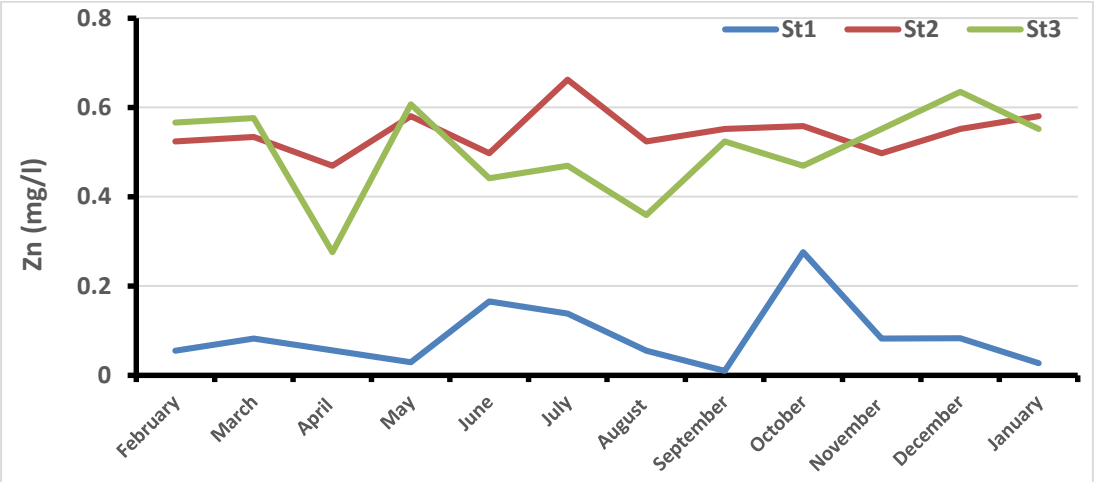


Fig. 10: Monthly variation in the Zinc element values at the three stations of the Iraqi marine water during the period from February 2018 to January 2019.

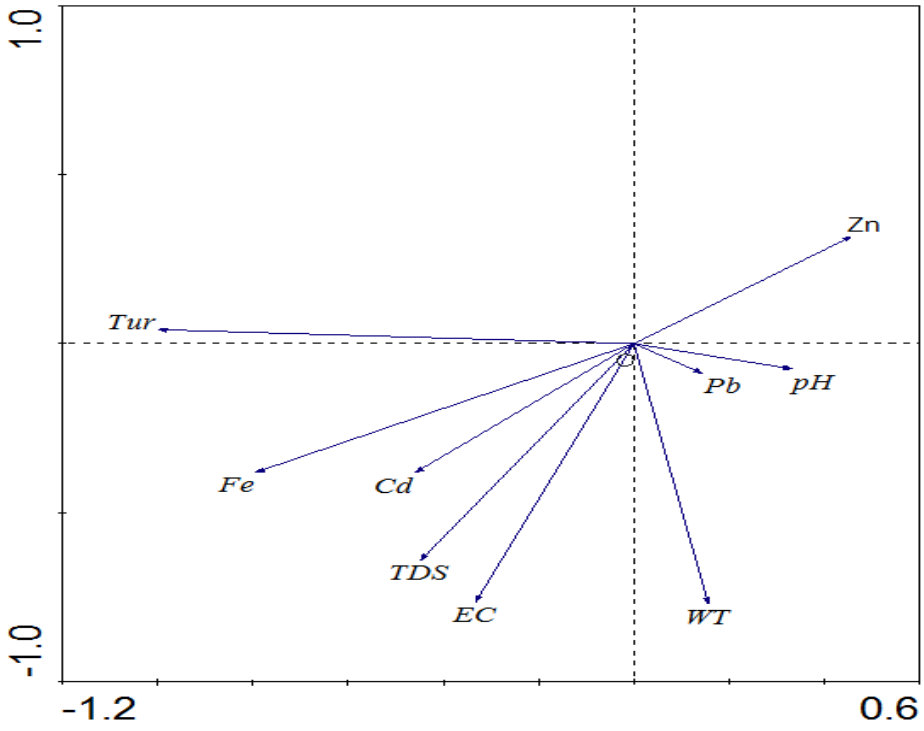


Fig. 11: Illustrates the relationship between numerous environmental factors which are concerned within this study.

### 3.10 Statistical analysis

From the figure above we noticed a correlation between the different parameters on the one hand there is a positive correlation between the levels of Pb and pH and Zn. These parameters increase linearly with each other. On the other hand, we detected another positive relation between the turbidity, total dissolved solid, Cadmium and iron. Also theses parameters increase linearly with each other. Therefore, we conclude that the increase in turbidity is directly associated with a higher level of adsorption of cadmium and iron on the surface of the suspended particles found in the marine waters. Finally, temperature showed Weak correlation with all measured elements.

## 4. Conclusions

Water quality overall Iraqi rivers is facing deterioration over time. Physicochemical parameter levels vary overall the year due to their association with anthropogenic sources and meteorological conditions. Within this study variation in water temperature, pH, Salinity, Conductivity and Turbidity were determined in the field and concentrations of major water pollutants. The highest variations in water temperature between Summer and Winter was depending mainly on the variations in the air temperature which was the lowest during Winter due to the short day period and highest in Summer due to the long day period. Levels of TDS increased from station 1 towards station 3, at the mouth of Khor Abdullah which opened to the Arabian Gulf the highly saline body, this coincides with results obtained for the Shatt Al-Arab river. By dilution of water in Khor Abdullah due to discharge of freshwater from Southern Iraqi Marshes led to reducing TDS in Khor Abdullah compared to Shatt Al-Arab river in which its water is effected heavily by discharge water of Tigris and Euphrates as well as the effect of tides from the Arabian Gulf. In conclusion, this study is considered as a data base involving the many different parameters and alterable changes in the Iraqi marine water.

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# التغيرات في تراكيز بعض العناصر الثقيلة وعلاقتها ببعض العوامل البيئية في المياه الساحلية العراقية

بسام عاشور رشيد[1]، محمد فارس عباس[2]،فارس جاسم محمد[3]

1. قسم الكيمياء وتلوث البيئة البحرية – مركز علوم البحار – جامعة البصرة –العراق.
2. قسم الاحياء وتلوث البيئة البحرية – مركز علوم البحار – جامعة البصرة –العراق
3. قسم الكيمياء وتلوث البيئة البحرية – مركز علوم البحار – جامعة البصرة –العراق

**المستخلص**

تم تسجيل عوامل بيئية متعددة في المناطق القريبة من ميناء البصرة النفطي وبالقرب من العوامة 17 بالإضافة إلى ميناء أم قصر. تمثل المواقع الثلاثة المعنية بهذه الدراسة مواقع حركة البواخر وناقلات النفط. حيث أجريت الدراسة الشهرية على التغيرات الحاصلة في التوصيلية ، درجة حرارة الماء ، الاس الهيدروجيني ، العكورة و المواد الذائبة الكلية. أشارت الدراسة الحالية إلى أن قيم درجات الحرارة كانت ضمن معدلاتها السنوية حيث تراوحت بين 14-34 درجة مئوية ، و كانت قيم الاس الهيدروجيني ضمن نطاقات الخصائص السائدة للمياه الساحلية العراقية ، بينما سجلت التوصيلية قيم منخفضة خلال شهر كانون الثاني في جميع محطات الدراسة ، علاوة على ذلك ، انخفضت قيم العكورة في المحطة الثالثة وسجلت قيم عالية في المحطتين الأولى والثانية وهذا هو الحال في قيم المواد الصلبة الذائبة الكلية أيضًا. تمت دراسة العلاقة بين هذه العوامل مع أربعة معادن ثقيلة. تعتبر هذه الدراسة قاعدة بيانات تتضمن العديد من العوامل المختلفة والتأثيرات المتغيرة في المياه البحرية العراقية .