DOI: http://dx.doi.org/10.21123/bsj.2022.7599

Evaluation of Some Heavy Metals, Their Fate and Transportation in Water, Sediment, and Some Biota within AL-Musayyib River, Babylon Governorate, Iraq

Ashwak Falih Kaizal[1] *Jasim Mohammed Salman*[2*] *Patryk Kot*[3]

[1]Department of Biology, College of Science for Woman, University of Babylon, Babylon,Iraq.
[2]Department of Biology, College of Science, University of Babylon, Babylon,Iraq.
[2]Environmental Research& Study Center, University of Babylon,Babylon,Iraq.
[3]Built Environment and Sustainable Technologies (BEST) Research Institute,Liverpool John Moores University, UK.
*Corresponding author: jasimsalman@uobabylon.edu.iq
E-mail addresses: ashwak.aliraq@yahoo.com , pa.kot@ljmu.ac.uk

Received 14/7/2022, Revised 13/8/2022, Accepted 15/8/2022, Published Online First 20/9/2022
Published 1/4/2023

Abstract:

This study estimated seven heavy metals (Fe, Cu, Zn, Pb, Ni, Cd, Cr) in water (dissolved and particulate phase), sediments and some aquatic organisms including two species from aquatic plants (*Ceratophyllum demersum*&*Phragmites australis*); one species of clam (*Psedontopeses euphratics*) and two species from fish (*Oreochromis aureus*& *Leuciscus vorax*)in four sites within Mashroo AL- Musayyib channel project/ branch of Euphrates river, Babylon , medial of Iraq . This aims to show the concentration of these elements, their fate and the mechanisms of their transmission through the food chain in this lotic aquatic system ; also in addition to examining some physicochemical properties of river water such as water temperature (WT),air temperature (AT),pH , electrical conductivity (EC) , salinity ,total dissolved solid (TDS), total solid suspended (TSS) , dissolved oxygen (DO) and biological oxygen demand (BOD_5) .The occurrence in heavy metals in water was found in the order in the Dissolved phase :- Zn> Fe > Cu> Ni>Pb> Cr > Cd, the zinc element recorded the highest rate in site two for spring season while the cadmium element recorded the lowest rate in site one for spring season. In the particulate phase:- Zn> Cu >Fe > Ni>Pb> Cr > Cd, the zinc element recorded the highest rate in site two for spring season while the cadmium element recorded the lowest rate in site four for spring season. The sediment order was Zn> Cu >Fe >Pb> Ni > Cd > Cr where the zinc element recorded the highest rate in site two for spring season where as the chromium element recorded the lowest rate in site two for spring. In aquatic plant the order was in *C. demersum* :Zn> Fe > Cu>Pb> Cr > Ni > Cd, the zinc element recorded the highest rate in site four for winter season while the cadmium element recorded the lowest rate in site one for autumn season. In *P. australis*: Zn> Fe > Cu>Pb> Cd > Ni > Cr , the zinc element recorded the highest rate in site two for spring season while the chromium element recorded the lowest rate in site two for spring season. In clam the order was: Zn> Fe > Cu> Ni >Pb> Cd > Cr where the zinc element recorded the highest rate in site two for spring season while the chromium recorded the lowest value in site 3 through winter 2021.In fish species (*O. aureas*) the order was Fe > Zn > Cu>Pb> Cr > Cd > Ni. The iron element recorded as the highest rate in site 2 in spring 2021 whilethe element that recorded the lowest rate was Ni in site 2for spring in *L. vorax*. The iron element recorded the highest rate in site one for summer season where as the Nickel was recorded a lower value in site four in spring2021.

Keywords: Aquatic biota, Euphrates River, Heavy metals, Lotic ecosystem, Sediments, Water quality

Introduction:

Heavy metals are naturally occurring in different environmental media but their wide range of industrial, domestic, agricultural, medical, and technological applicationshave resulted in their widespread distribution in the environment, raising concerns about their potential efforts [1]. Heavy metals have been defined as elements which have an atomic number more than 20 and a density compared to water more than 5 g/cm^3, which are naturally originating and spread in nature very widely. It moves between parts and components of the environment on an ongoing basis [2]. Arroyo and Molinos-Senante[3]mentioned the term "heavy metals" is frequently used to refer to metals and semimetals (metalloids) that have been linked to contamination, potential toxicity, or ecotoxicity." Very recently, heavy metals have occurred in the aquatic environment by natural and anthropogenic sources.Weathering of metal-bearing rocks and volcanic eruptions are natural sources of heavy metals in the environment, but global trends of industrialization and urbanization on land have increased the anthropogenic share of heavy metals in aquatic systems [4]. Heavy metals are hazardous even in low concentrations because they are not biodegradable and accumulated in sediments and biota [5].

Geological and erosion processes naturally release heavy metals into the aquatic environment and these metals reach from the original natural source of rocks and sediments to the aquatic environment and these metals are dissolved or suspended in rain water that falls on the soil's surface or suspended in the air to be transported by wind from one location to another [6]. Volcanic activity is another natural source that contributes to the contamination of the aquatic environment. It can be reached by acid rain loaded with various pollutants, including toxic elements[7].In nature, excessive trace metal concentrations can be caused by geological events like volcanic eruptions, rock weathering, and water-induced leaching into rivers, lakes, and oceans..industrial activities a significant source of heavy metal pollution in the environment is caused by industries such as petroleum, oil refineries, iron and steel plants, copper, glass, aluminum, tanning plants, fertilizers, pesticides, gasoline, and others[8].On the other hand, anthropogenic sources include the disposal of sewage waste, mining activities, agricultural activities, the release of industrial wastes into water bodies, and numerous other human activities that release metal pollutants into the aquatic environment[9]. Heavy metals are continuously accumulated in rivers and deposited as sinks in marine sediment. The major issues associated with heavy metal persistence are toxicity, bioaccumulation, and biomagnifications, which have long-term consequences for the ecosystem, human health, and other living organisms [10]. Most researchers agreed that heavy metals are among the dangerous groups polluting water and cause direct dangers to the lives of most aquatic organisms and humans alike by moving through the food chain to cause accumulation in the levels of that chain for life in different ecosystems [11]. Anbuselvan *et al*. [12] reached in studying some sources of environmental pollution in sediments to indicated that the physical characteristics were within the permissible limits, except for conductivity and showed that the EC and suspended solids as they exceed these limits and that the chemical properties such as calcium, sodium, potassium, magnesium, fluoride and chlorides were within the limits allowed except for sulfates, bicarbonates and phosphates.Salman et al [13]studied the fate of Some Heavy Metals (Cd, Cu, Pb, Fe and Zn) in water and sediments in lotic ecosystem. The findings revealed that heavy metal concentrations in water were higher in the particulate phase than in the dissolved phase. Habeeb *et al.*[14]studied water quality and heavy metals in water, sediment, and aquatic macrophytes in the lotic ecosystem, with the goal of detecting potential environmental effects on the eastern Euphrates drainage in Babylon province .Al-Zughaiby *et al*[15] determined the correlation between some trace element concentrations in the Euphrates River of Iraq.Based on this research, the rates of concentration of trace element were found in water and soluble form and study sites .Hassan et al. [16] studied the distribution of polycyclic aromatic hydrocarbons (PAHs) residues in Euphrates River water and sediment, despite long-standing restrictions on their use and production, the findings indicated that the Euphrates River was contaminated by petroleum hydrocarbons and their residues.Salman and Al-Shammary[17] determined the quality of water in Hilla river by examining many physical and chemical properties .

The current study aims to examine water quality and assessing some heavy metal concentrations in Al- Musayyib project on Euphrates River in the middle of Iraq, then indicating their transmission and fate in water, sediment, and some organisms within the study area.

Materials and Methods:

Description of the Study Area

The research area includes AL-Musayyib channel, which represents Al- Musayyib Al-Kaber project and is located in the north-east of Babylon Governorate, to the east of the Mahawil and Musayyib districts. Its source is located on the Euphrates River, north of Al-Hindiyyah barrage, within 9.6 km until the end of the project at (Al-Massab Al aam) that separates the Babil Governorate from Wasit Governorate, within the limits of 49.5 km, and the project is branched into many streams with a total of 12 km / length of 12 km. The main channel is branching from the left side of the Euphrates River in the city of Al-Musayyib is 9.9 km north of Al-Hindiya, and it extends east to 49.5 km. (Fig. 1). The study area includes four sites on the river:

Site 1: Euphrates River near the city of Al-Musayyib, north of Hindiya barrage, within 9.6 km. This site is characterized by high water level in the river in most seasons, as the abundance of aquatic plants such as *Phragmites australlis* and *Ceratophyllum demersum* is noted.

Site 2: AL-Musayyib channel near Hilla-Baghdad street,near the technical institute, it was high traffic density, former military, industrial zones, which represents the Mashroo Al-musayyib Al- kaber and is located in the north-east of Babil Governorate, to the east of the Mahawil and Musayyib districts and clear sediments are noted at the edge of the river and a clear spread of plants, *Phragmites australis* and *Ceratophyllum demersum*.

Site 3: located near Baghdad-Basrah highway and many agricultural areas have been noted around this site. There are some species of plants in the sediment edge of the river.

Site 4: located after the city of Jabla it is an agricultural region until the end of the Al-Musayyib channel that separates Babil Governorate from Wasit Governorate, within the limits of 49.5 km.

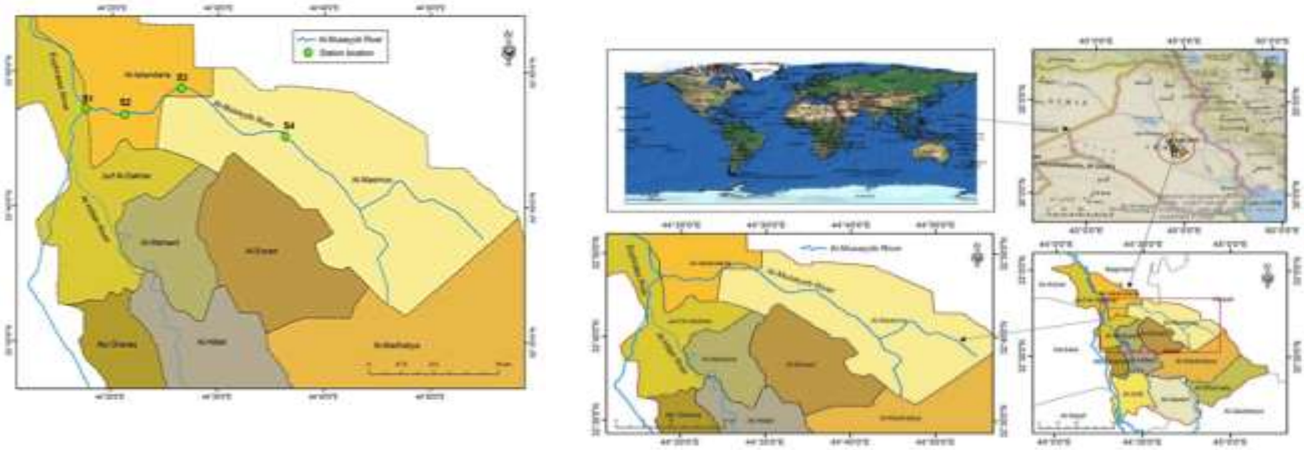


Figure 1. Map of the Study sites on Al-Musayyib river,Babylon governorate,Iraq.(Source:Ministry of Water recourses,Baghdad-Iraq)

Sample collection

Water samples Collection

Sampling was carried out in four sites monthly, from January to December 2021.Samples were collected from the middle and the riverside to assess the physicochemical properties of water with the evaluation of some heavy metals, using the polyethylene bottles with three replicates for each sample according to [18].

Sediment sample collection

Grab sampler was used to collect benthic sediment samples from the same place where plant samples were collected preserved in marked plastic bags and frozen until analysis .

Aquatic organisms Sample

Aquatic plant collection

Aquatic plant samples were collected and then two species of aquatic plants were classified:- *Phragmitus australis* and *Ceratophyllum demersum*a fter being washed in river water to remove suspended particles, they were placed in plastic bags and transported to the laboratory[19].

Clam Sample collection

Clam samples were collected monthly using the Hand method. The samples were washed with river water for the purpose of getting rid of plankton and obtaining the individuals of different sizes. After that, the samples were placed in marked bags inside a cooler box until they reached the laboratory and the species of clam as *Psedontopeses euphratics* [28].

Fish Sample collection

Fish samples were collected monthly using the method of fishing and two species ,*Oreochromis aureas*& *Leuciscus vorax* of fish were obtained for the four sites .

Physicochemical analysis

Temperature of the water was assessed using the Multi-meter directly (manufactured by Hana company).Air Temperature (AT) was assessed using the thermometer from 0-100, while pH and electrical conductivity (EC) was calculated using Multi-Meter[20]. The salinity was calculated according to the results of electrical conductivity

results in accordance with what was stated by Mackerethet *al*. [18] .
Total dissolved solid (TDS) was assessed using multi-meter (manufactured by Hanna) and is expressed in units of mg/L. and total solid suspended (TSS) were measured by filtering [19]. Dissolved Oxygen DO& BOD_5 was measured by Winkler method [19].

Heavy metal extraction methods

Measuring of heavy metals in water

The concentrations of heavy metals under study were estimated according to [20] where the method included the following: - 50 ml of water samples were taken, the water samples were placed inside a clean glass beaker with a capacity of 100 ml, and 5 ml of concentrated nitric acid was added to digest the samples. The beaker was heated on a hot plate, and the heating continued on the plate until it reached the stage of pre-drying, and again added to the samples 5 ml of concentrated nitric acid while continuing to heat in order to obtain a precipitate, the solution was left to cool down and then complete the volume to 25 ml with deionized water. The solution was filtered using millipore filter paper 0.45 µm. Then the samples were ready to determine the concentrations of heavy metals in them by flam atomic absorption spectrophotometer (FAAS) and expressed by mg/l

Measuring heavy metals in Sediment

Heavy metals were estimated for sediment samples collected, according to [21]. 2 g of air-dried sediment was weighted, placed in a clean glass flask, 10 ml was added to it from H_2SO_4, HNO3 and $HClO_4$ and 1:1:3. The watch bottle was placed in the flask, to prevent concentrated acids from evaporating, and the samples were heated on the surface of a hot plate at a temperature of 105° for 90 minutes and on the Hot Plat, mitigated by adding deionized water to 50 ml. Absorption was estimated for each sample by the atomic absorption spectrometer, by using the slope equations of the heavy metal standard curves under study, the absorption is converted into concentration units, and the results are expressed in mg/g dry weight.

Determination of Heavy metals in sample of aquatic organisms Sample (Plant, Clam, Fish)

Heavy metals were estimated in samples (collected, dried and milled), where sample powder was digested in a way that digested acid by method of APHA [20]. 3 g of sample powder to be digested was placed inside in volumetric flask size 25 ml, then 3 ml of concentrated Perchloric acid ($HClO_4$) was added to the solution and covered the cup using the watch glass bottle, and heated quietly and on a hot plate, and we gradually raise the temperature, in order to complete the digestion process and when the mixture reaches the stage of dehydration we leave the cup to cool, and add again 3 ml of the solution of concentrated nitric acid (HNO_3) covering the cup and continue to heat until the digestion is finished, where we get a mixture consisting in a delicate and light color called (light colored digestive). We fumigated until approached the dry phase, and added 5 ml of diluted hydrochloric acid (HCl) solution with water by 1:1, then heating, to dissolve the remaining sample after digestion, and then distilled water was added. The filtration process was done to get rid of the remaining and non-dissolved materials, and the size of the solution was adjusted according to the expected concentration in the samples to a size 100ml, 50 ml or less, as the sample is ready for analysis, using flam atomic absorption spectrophotometer (type SHEMADZU AA 7000).

Results and Discussion

Water quality and Heavy metals in water

The river's physicochemical characteristics are shown in (Fig.2). The air temperature ranged between 12.5 - 46 C° in site two in February and site three in July respectively, while the water temperature ranged between 14 – 38 C°, it increased during hot months and decreased during cold months. These results corresponded with other Iraqi studies [22, 23]. The pH values ranged between 6.6 – 8.34 in site one in may2021 and January respectively. The pH values are affected by many factors such as CO2 concentration [24] and nature of climate [25]. Values of these parameters ranged from 1.4-6.3 mg/l in site one in September and site one in march respectively. BOD_5 values ranged between 0.3 – 3.9 mg/l in site four in may and January respectively.EC values ranged 369-594 µs/cm in site two in August and site four in December respectively. Salinity values ranged 0.2- 0.4 ppt in April , July, August and December respectively. TDS values ranged 250-420 (mg/l) in site two in August and site four in December respectively. TSS values ranged 3.667 – 46.667 mg/l in site two in February and site four in September respectively. Several studies have indicated that rivers are exposed to pollution with heavy metals from various sources such as household waste, mining activities, and agricultural activities such as adding fertilizers and pesticides which negatively affects the balance of the aquatic ecosystem [26].The results of the current study showed that the rates of heavy metals concentrations in water for the four study sites are in the following order in dissolved phase:- Zn> Fe > Cu> Ni>Pb> Cr > Cd. In particulate phase:- Zn> Cu >Fe > Ni>Pb> Cr >Cd, the zinc element recorded the highest rate of concentration of the studied elements in the dissolved water and particulate matter while the cadmium element recorded the lowest rate Table .1, Fig.3. The reason for the rise of the element zinc may be attributed to the diversity in the sources of pollution with this element or the difference in the quantities of polluting materials to the river or it may be caused by the difference in the water level or some of the life activities carried out by some living organisms that are affected by the amount of food, reproduction and photoperiod [27] . The reason for the low concentrations of some elements such as cadmium may be due to the tendency accumulation of these elements in the bodies of plankton and aquatic plants with filter feeding and its adsorption by sediments and this agreed with [28,29]. As for the higher concentrations of some elements (iron and copper) in the particulate phase than the dissolved ones this is attributed to the tendency of most elements to adsorption and bonding the water column contains clay and organic matter on the surfaces of suspended particulate matter, because when it dissolves in water it forms suspended colloids and is fixed before organo plankton or cations easily attracted by clay minerals or organic materials.

Table 1. Mean of heavy metal concentration in water of study area (µg/l)

Heavy metal	Max.		Min.	
	Dissolved	**Particulate**	**Dissolved**	**Particulate**
Cr	1.153	0.5367	0.103	0.136
Fe	1553	2063	537	313
Cu	1263	2083	360	247
Zn	30227	22287	8557	5820
Pb	3.593	1.263	0.2967	0.370
Ni	12.71	5.443	0.1267	0.217
Cd	0.88	0.985	0.03	0.033

Table 2. Mean of heavy metal concentration in Sediment of study area (µg/g)

Heavy metal	Max.		Min.	
Cr	1.24	St.2 Spring 2021	0.1333	St.2 Winter
Fe	8407	St.1 Autumn	1533	St.3 Winter
Cu	18207	St.4Autumn	3250	St.3 Winter
Zn	27497	St.2 Spring	10593	St.3 Winter
Pb	7.5367	St.2 Spring	0.3500	St.3 Winter
Ni	5.9700	St.2 Spring	0.3633	St.3 Winter
Cd	1.6033	St.1 Autumn	0.0733	St.2 Winter

Table 3. Mean of heavy metal concentration in Aquatic plant of study area (µg/g)

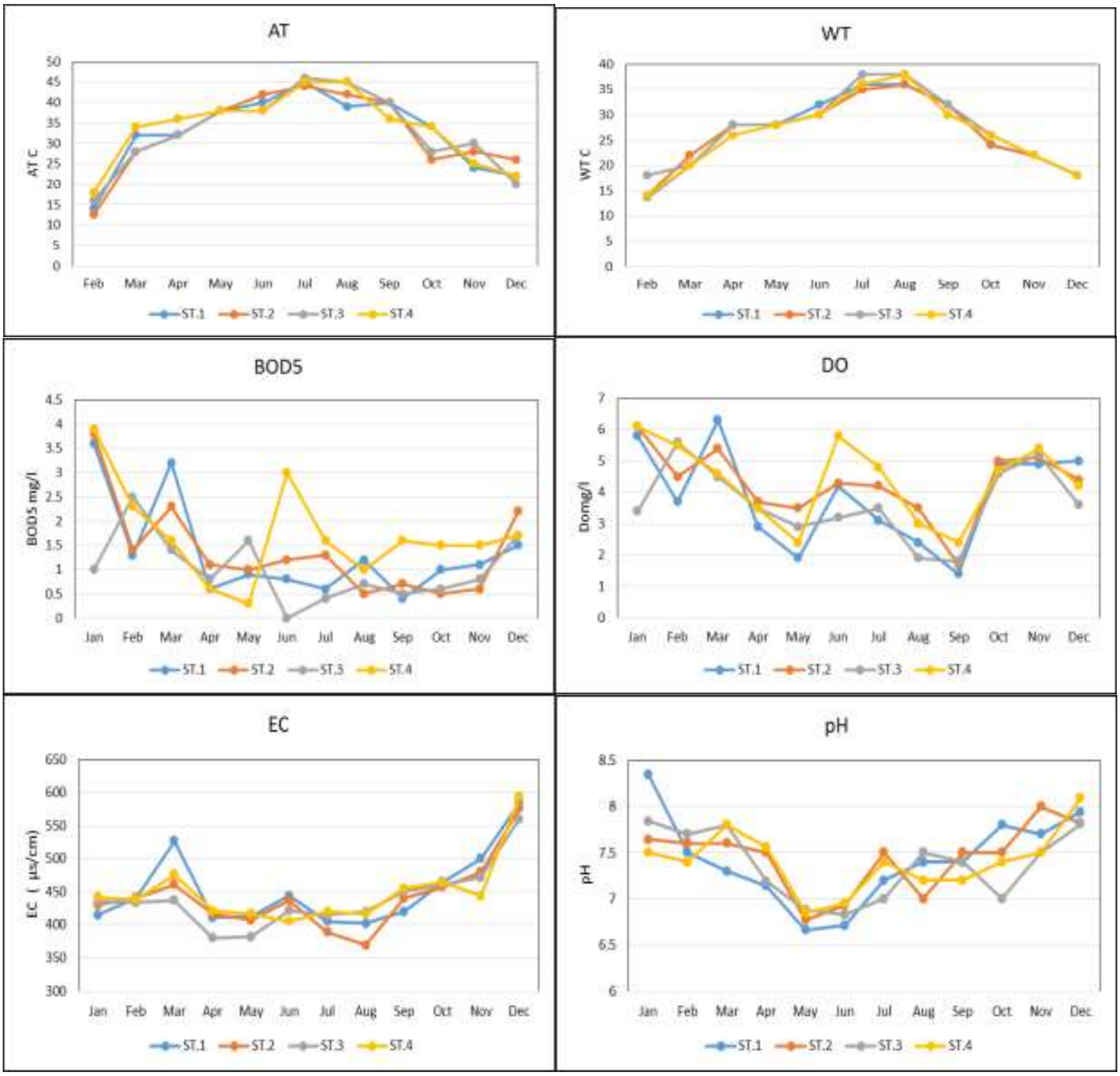
Heavy metals	Max.				Min.			
	C. demersum		***P. australis***		***C. demersum***		***P. australis***	
Cr	0.4800	St 2 spring 2021	0.3700	St 2 spring	0.0333	St.3&4 summer	0.0700	St.3 summer
Fe	12197	St 2 spring	18133	St 2 spring	4520	St.2&3 Winter	3497	St.1 Winter
Cu	10367	St 2 spring	11567	St 2 spring	4143	St.3 Summer	5150	St.3 Summer
Zn	17493	St.4 Winter	19067	St 2 spring	7160	St.3 Summer	10170	St.3 Summer
Pb	0.9233	St.3 Summer	1.0567	St.1 Autumn	0.040	St.4 Winter	0.0633	St.4 Winter
Ni	0.4333	St 2 spring	0.5167	St 2 spring	0.1033	St.3 Winter	0.1333	St.3 Summer
Cd	0.4200	St.1 Autumn	0.9000	St.1 Autumn	0.0667	St.3 Summer	0.2233	St.3 Summer

Table 4. Mean of heavy metal concentration in Clam of study area(µg/g)

Heavy metals	Clam			
	Max.		Min.	
Cr	0.1733	winter in st.3 2021	0.0047	summer in st.3
Fe	13563	winter in st.4	5473	summer in st.3
Cu	9500	spring in st.2	3277	summer in st.3
Zn	19267	spring in st.2	11243	summer in st.3
Pb	1.3167	Autumn in st.1	0.5433	summer in st.3
Ni	1.4633	spring in st.1	0.32	Winter in st.4
Cd	0.9067	spring in st.4	0.0133	summer in st.3

Table 5. Mean of heavy metal concentration in Fish of study area (μg/g)

Heavy metals	Max.				Min.			
	O. aureas		*L. vorax*		*O. aureas*		*L. vorax*	
Cr	0.8667	St.4 autumn 2021	1.0567	St.2 spring	0.0733	St.2 autumn	0.0467	St.2 Winter
Fe	7817	St.2 spring	8437	St.1 summer	3170	St.2 Winter	3293	St.3 summer
Cu	2067	St.1 autume	2463	St.2 spring	380	St.3 Winter	290	St.3 Winter
Zn	4627	St.2 spring	7943	St.2 spring	1943	St.4 summer	1900	St.3 Winter
Pb	1.0667	St.2 spring	1.3903	St.2 spring	0.2267	St.1 Winter	0.2733	St.1 summer
Ni	0.2833	St.2 spring	0.5633	St.4 spring	0.0333	St.3 autumn	0.0133	St.3 autumn
Cd	0.3200	St.3 Winter	0.7000	St.2 spring	0.0133	St.3&St.1 in autumn and summer respectively	0.0133	St.3&St.1 in autumn and summer respectively



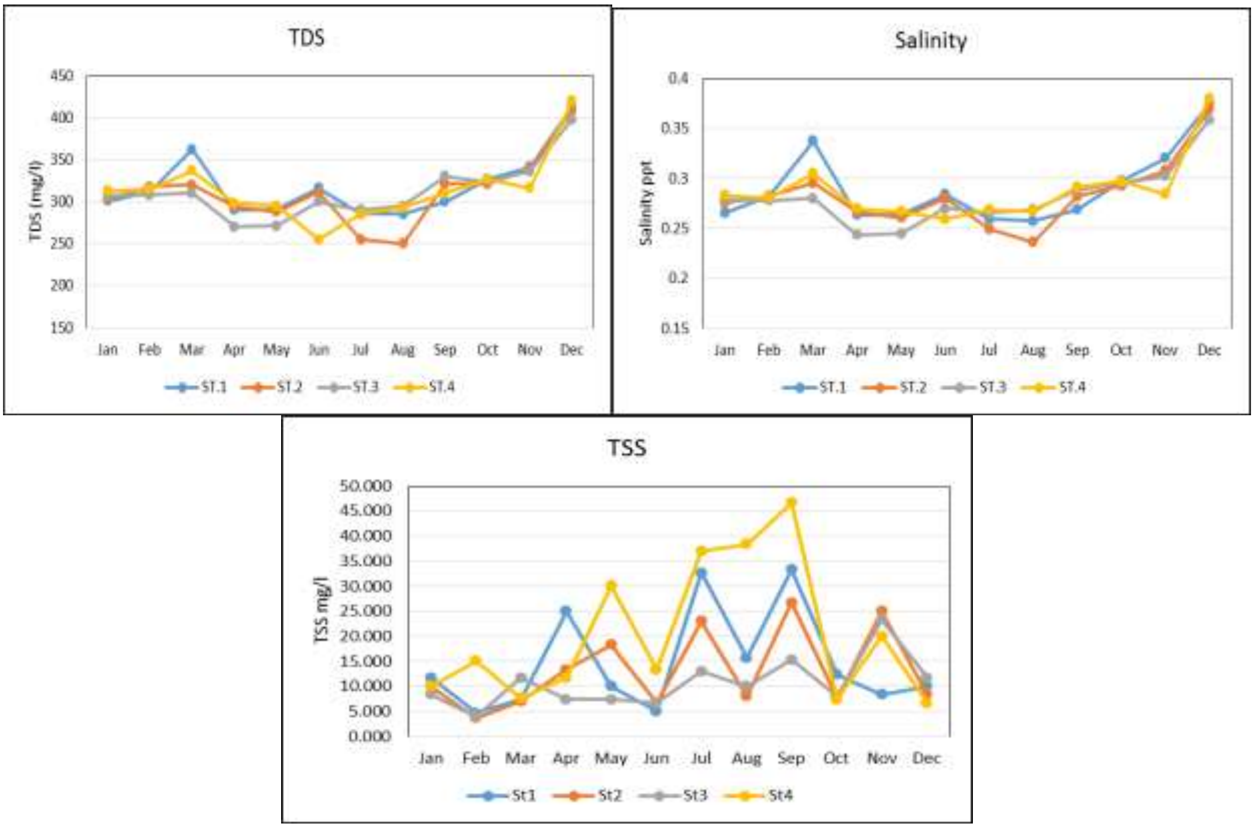
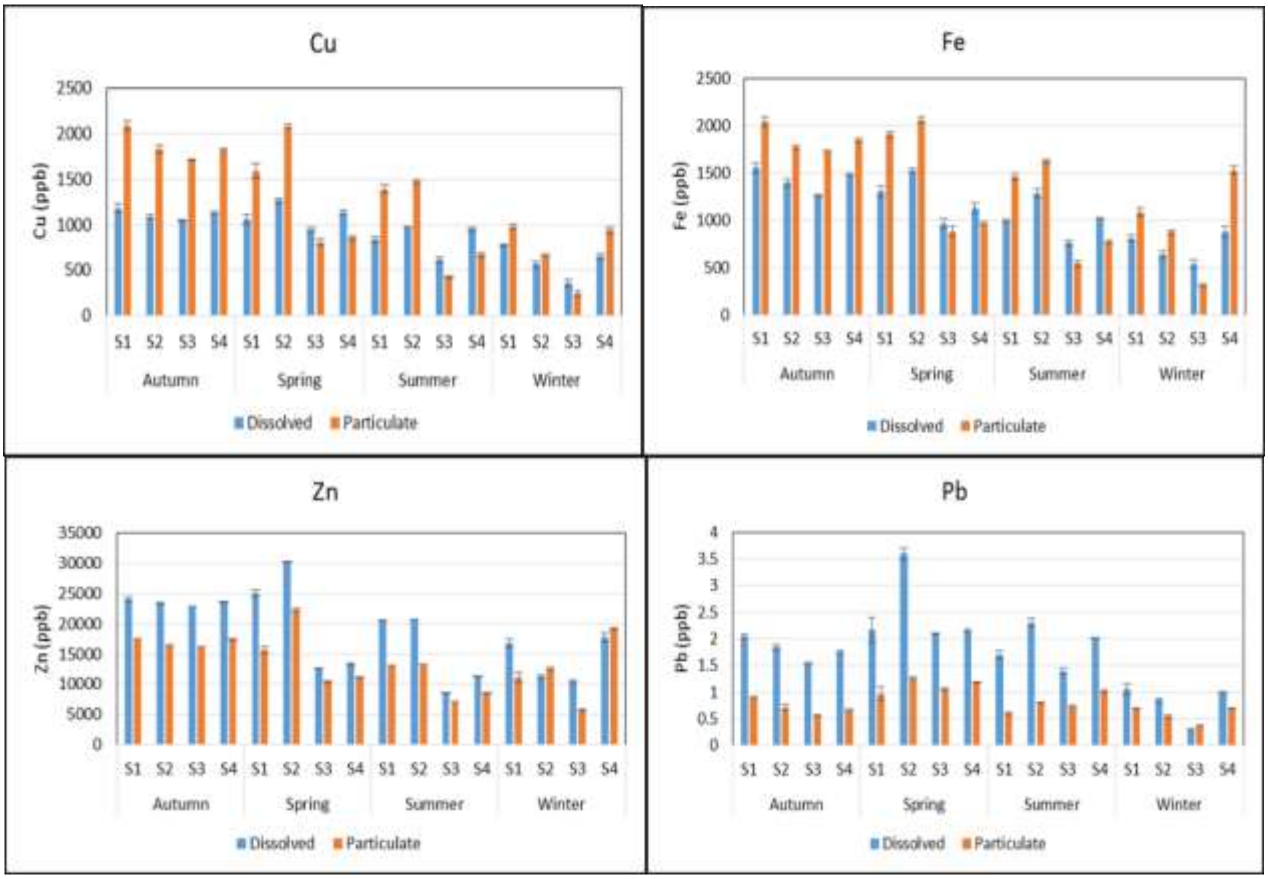


Figure 2. Physicochemical properties (WT, AT, DO, BOD_5, pH, EC, salinity, TDS, TSS)



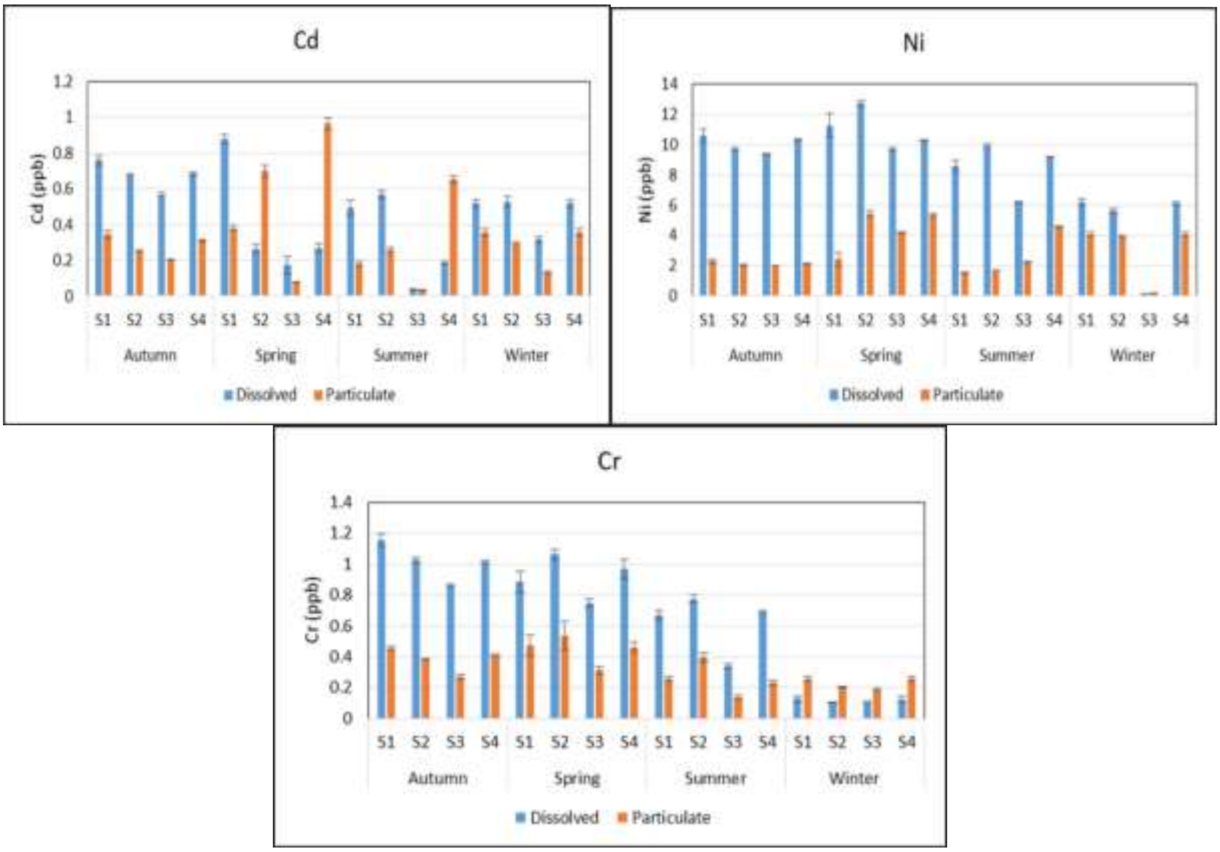


Figure 3. Iron, Copper, Zinc, Lead, Nickel, Cadmium, chromium Concentration rate µg /l in water

Heavy metals in Sediment

The sediments at the bottom of different water bodies represent a basin for the collection or storage of various water pollutants that have the ability to precipitate and adsorption on the surface of the particles that make up these sediments (mud, silt, and sand grains) and go down to the bottom area in the watery medium. As a result, heavy metals are among the most significant pollutants in the aquatic environment [30]. Sediments play an important role in returning these pollutants to water systems [31]. If these elements are released again to the water column when mixing occurs or they move through the food chain, then the quality of the sediment and its components are evidence of the quality and quantity of this pollution and the nature of its source tends to accumulate these pollutants gradually over time in the sediments [32]. The average concentrations of heavy elements in the sediments were for the four study stations Fig. 4, Table .2. Zn> Cu >Fe >Pb> Ni > Cd > Cr, the zinc element recorded the highest rate of concentration of the studied elements in the sediment while the chromium element recorded the lowest rate. Tannery is a major cause of Cr pollution in sediments. [33]. Organic substances, Cr salts, chloride ions, sulfides, sulfates, and nitrogen are present in untreated tannery effluent [34]. In addition, a significant amount of domestic and industrial wastewater is discharged into rivers which may explain the high level of Zn and Cu accumulation in sediments [35].

Heavy metals in Aquatic plant

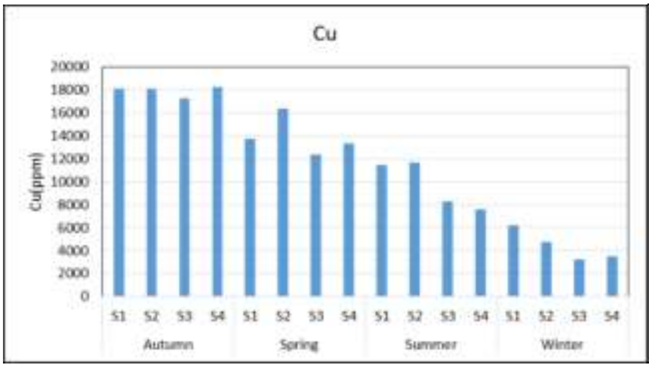
Aquatic plants can accumulate biogenic elements, toxic substances, including heavy metals, and they not only have a high assimilation potential. An issue of global concern is the presence of toxic heavy metal ions in aquatic systems. Heavy metals can accumulate along the food chain and have toxic effects even at low concentrations leading to significant ecological and health issues. They are hazards due to their solubility and mobility [36]. The average concentrations of heavy elements in the aquatic plant were for the four study sites Fig. 5, Table 3. In *C. demersum* Zn> Fe > Cu>Pb> Cr > Ni > Cd and in *P. australis* Zn> Fe > Cu>Pb> Cd > Ni > Cr ,the zinc element recorded the highest rate of concentration of the studied elements in the aquatic plant while the cadmium and chromium element recorded the lowest rate respectively in *C. demersum* and *P. australis* because sediments are a major sink for heavy metals in water and are crucial for aquatic organisms' uptake of heavy metals. Depending on the distribution of heavy metals in sediments and where the organisms were caught, the heavy metal concentrations in aquatic organisms in the three areas varied greatly [37]. Salman et al. [38] made a study in Euphrates river on *Ceratophyllum demersum*, *Phragmitus australis*, *Typha* *domingensis* and *Potamogeton pectinatus* plants and he found that those plants had the ability to accumulate heavy metals due to rates of concentrations which were higher in the studied plants more than sediments and water, this susceptibility varies with the variability of the source of contamination and different plant type. Al-Edani *et al,* [39] studied the ability of three plants to accumulate some h(Fe, Cd, Cu, and Pb)in two locations along the Shatt Al-Arab River, they found that rates of elements were high *C. demersum* that reflected good efficiency in removing element pollutants followed by *P. australis* and finally in *Cyperus rotundus.* Al-Samarrai [40] stated that study took place in the Euphrates River to assess the ability of four aquatic plants (*Ceratophyllum demersum*, *Phargmitus australis*, *Typha domingensis* and *Myriophyllum verticillatum*) to show evidence of contamination with heavy metals (mercury, lead, nickel manganese, cobalt, copper and iron). This study found high concentrations of these metals in plant tissues, thus demonstrating their suitability as indicators.

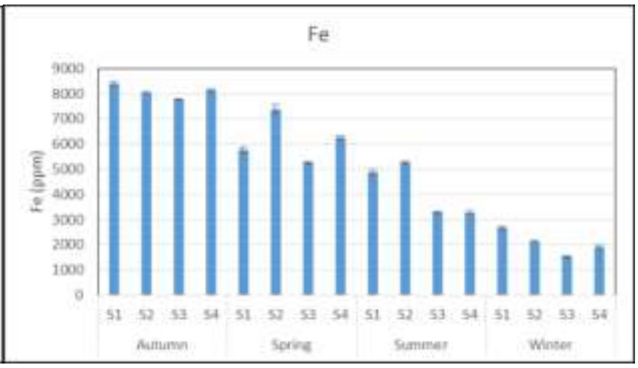
Heavy metals in Clam

The wide range of heavy metal accumulation in bivalve with filter feeding and from different food sources give an indication that they can use it as a guide or key to determine pollution levels in the environment [41] and mentioning [42] that there are numerous factors that influence the concentration of heavy metals in bivalve tissues including, element readiness, sampling time, and hydrochemical factors of ecosystem such as size, gender , reproductive cycle and variations in the tissue composition of the organism's body.The average concentrations of heavy elements in clam were for St.4, Fig. 6, Table 4 : Zn> Fe > Cu> Ni >Pb> Cd >Cr ,the concentration of heavy metals in bivalves is closely related to and indicative of the concentration of heavy metals in the sediment [43].Heavy metals in aquatic habitats tend to accumulate in biomes and biomagnify through the food chain due to their stability and persistence, and they are frequently regarded as highly potentially toxic contaminants [44]. There are many studies about clam on the Euphrates River, such as [45] and [46] that study fresh water clam as a Heavy Metal Bioaccumulation Indicator Organism and diversity of molluska in the Euphrates River, Iraq.

Heavy metal in Fish

The average concentrations of heavy elements in Fish were for the four study stations Fig. 7, Table 5: Fe > Zn > Cu>Pb> Cr > Cd >Ni Non-essential metals may accumulate in fish organs while essential metals are required for normal metabolism [47]. Essential metals include Fe, Cu, Zn and manganese (Mn), whereas nonessential metals are Hg, Pb, Ni and Cd [48]. As a result, levels in fish typically reflect levels found in the sediment and water of the specific aquatic environment from which they are sourced, as well as the time of exposure. fish have the ability to accumulate heavy metals in their tissues at higher levels than environmental concentrations due to absorption along the gill surface and the kidney, liver, and gut tract wall [49]. Heavy metal accumulation by organisms can be passive or selective, and differences in heavy metal accumulation by organisms can be due to differences in assimilation, egestion, or both [50]. Many studies estimated the concentration of some heavy metals (cadmium, lead, zinc, iron, manganese, selenium and nickel) in the mussels offish species and other aquatic biota collected from Euphrates river / middle of Iraq [51-55].





Baghdad Science Journal
2023, 20(2): 600-615
P-ISSN: 2078-8665
E-ISSN: 2411-7986

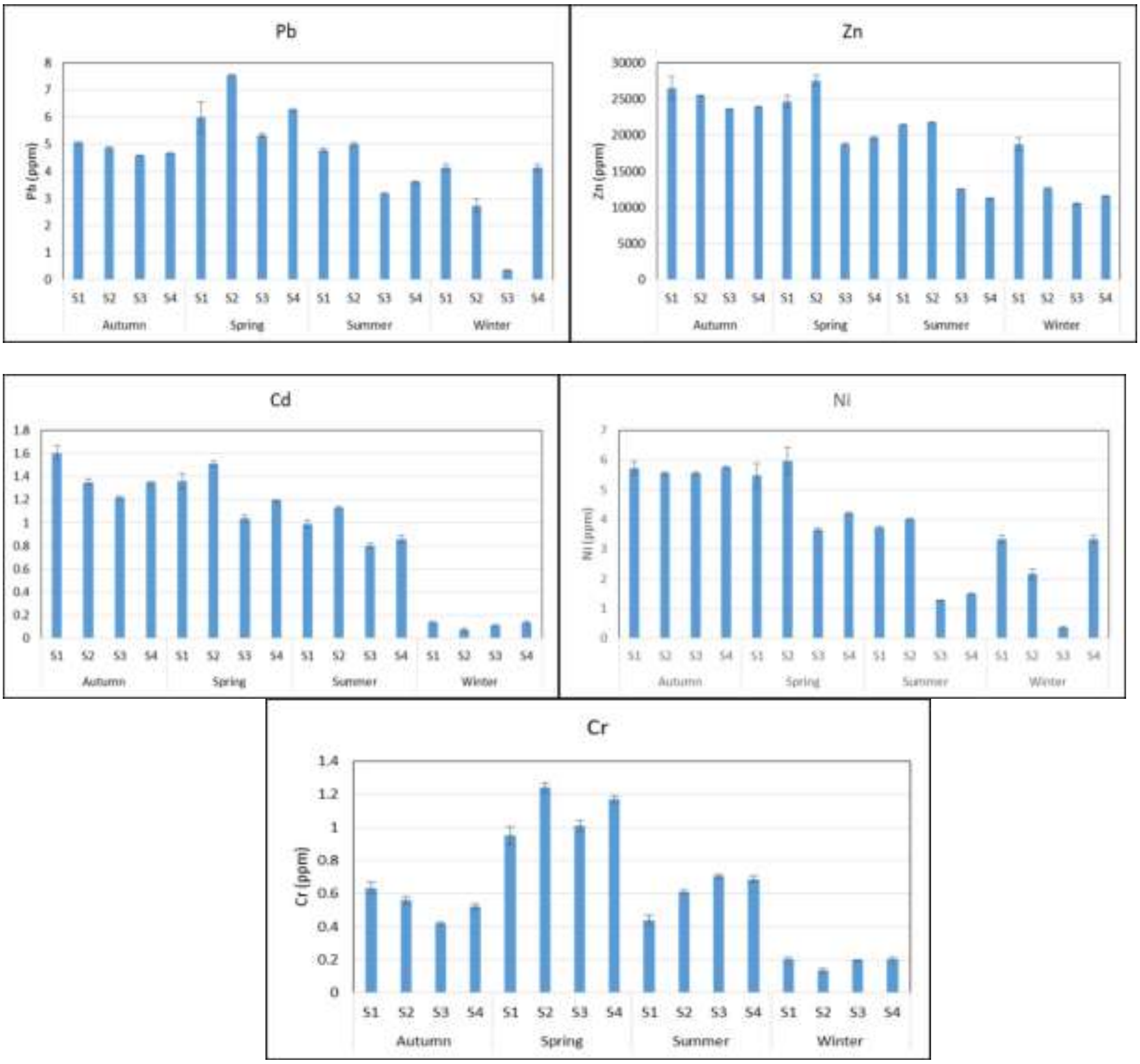
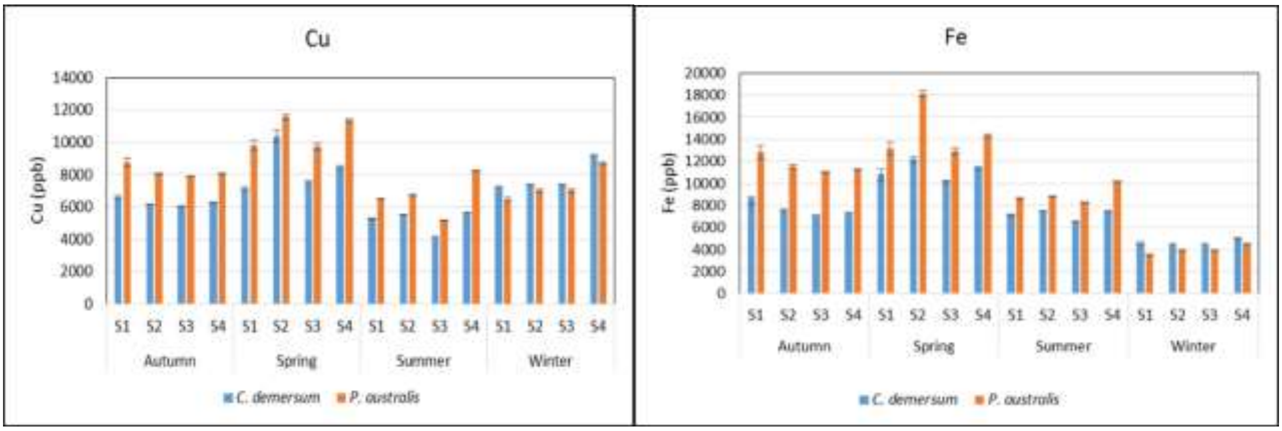


Figure 4. Iron, Copper, Zinc, Lead, Nickel, Cadmium, chromium Concentration rate µg /g in Sediment



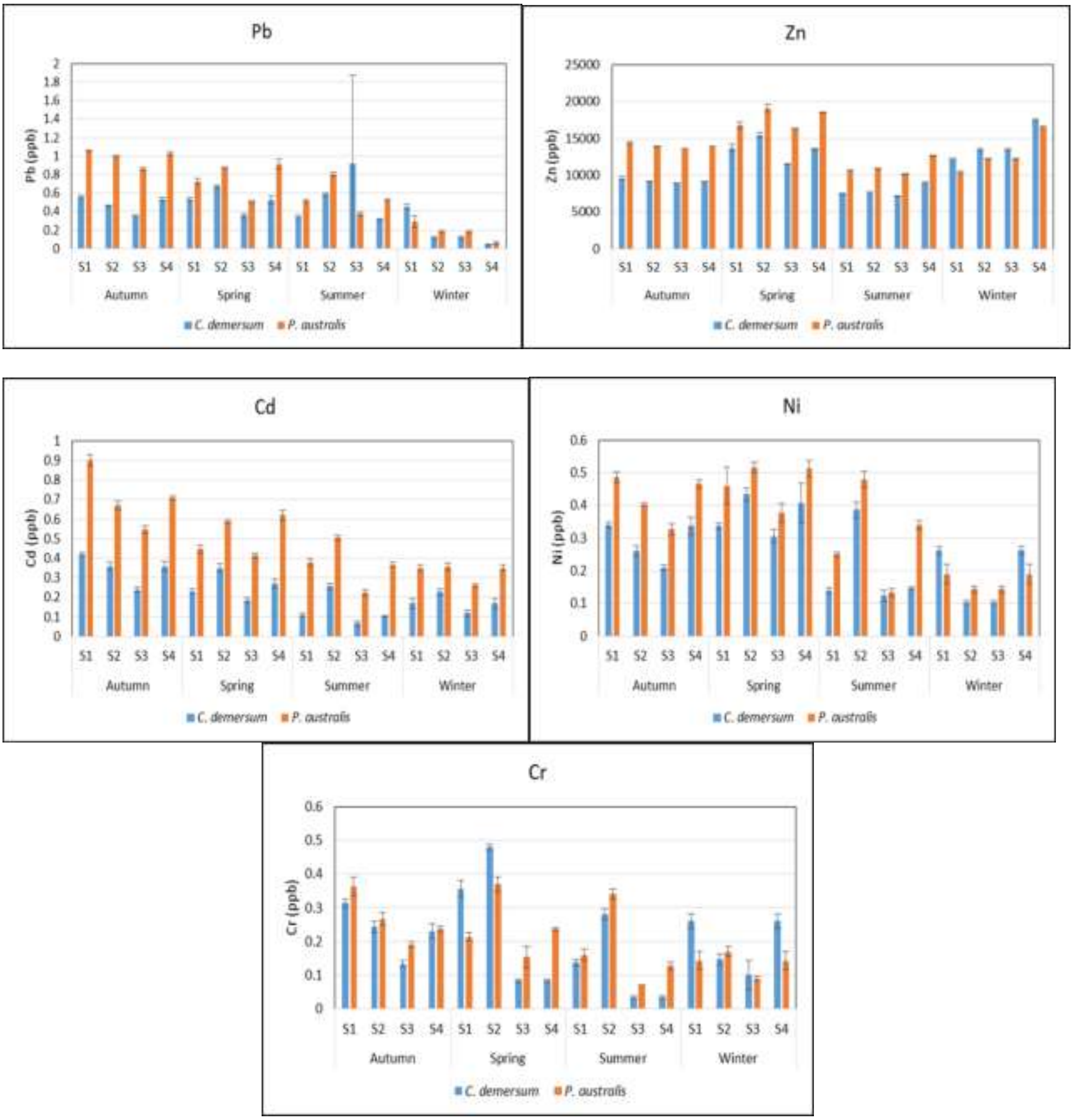
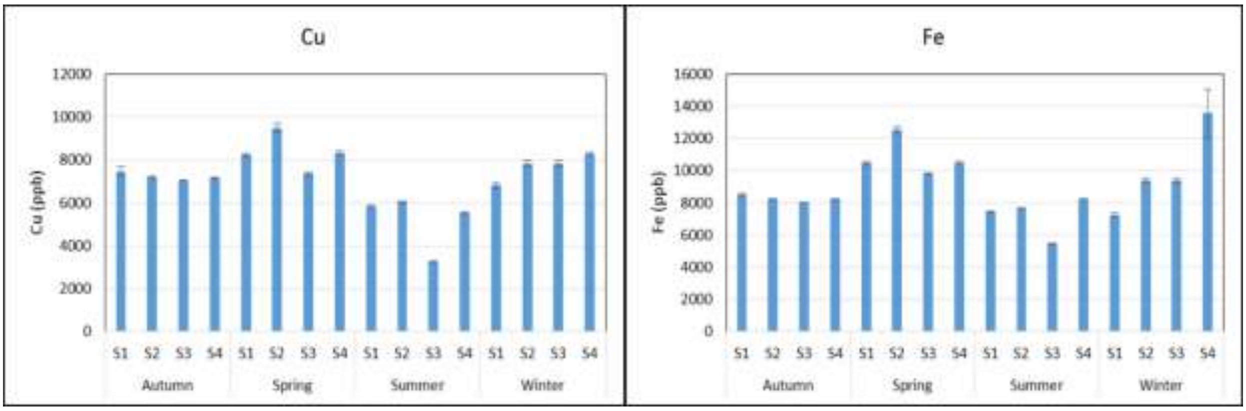


Figure 5. Iron, Copper, Zinc, Lead, Nickel, Cadmium, chromium Concentration rate µg /g in Aquatic plant



Baghdad Science Journal
2023, 20(2): 600-615
P-ISSN: 2078-8665
E-ISSN: 2411-7986

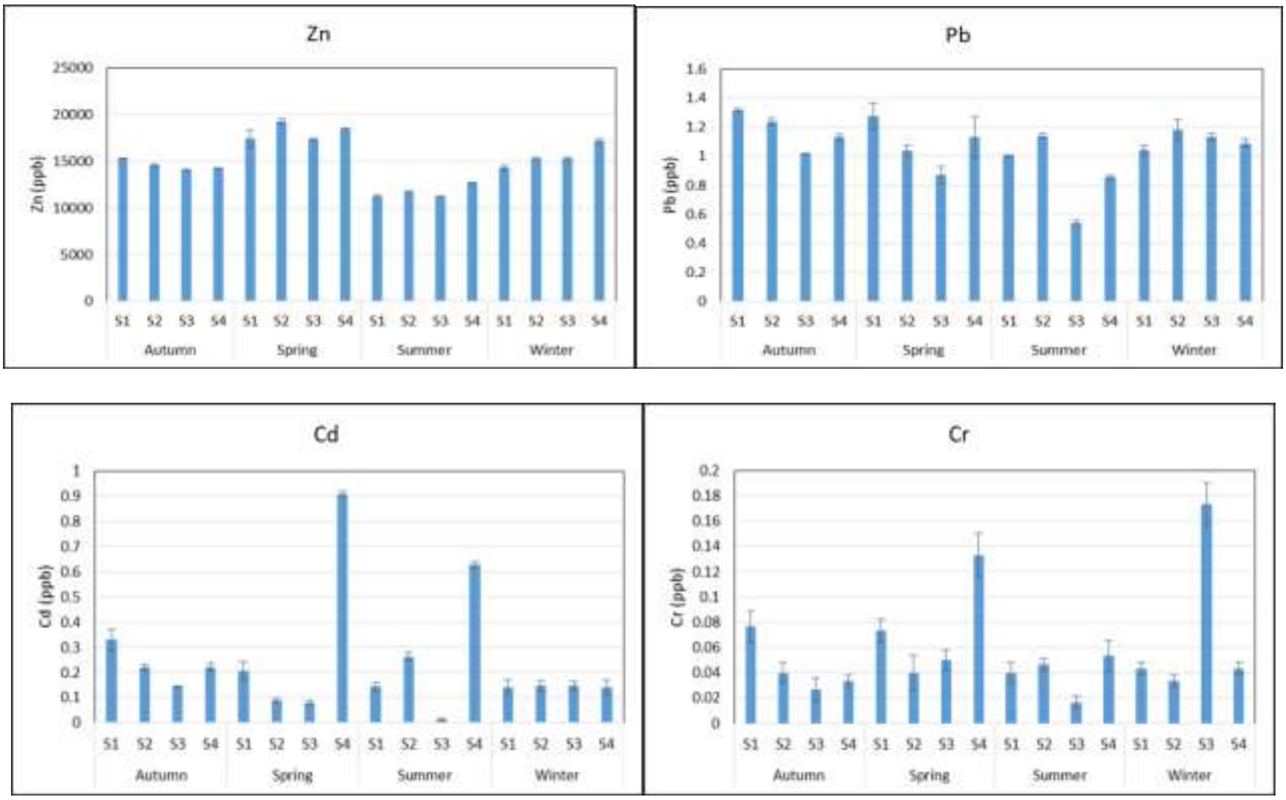
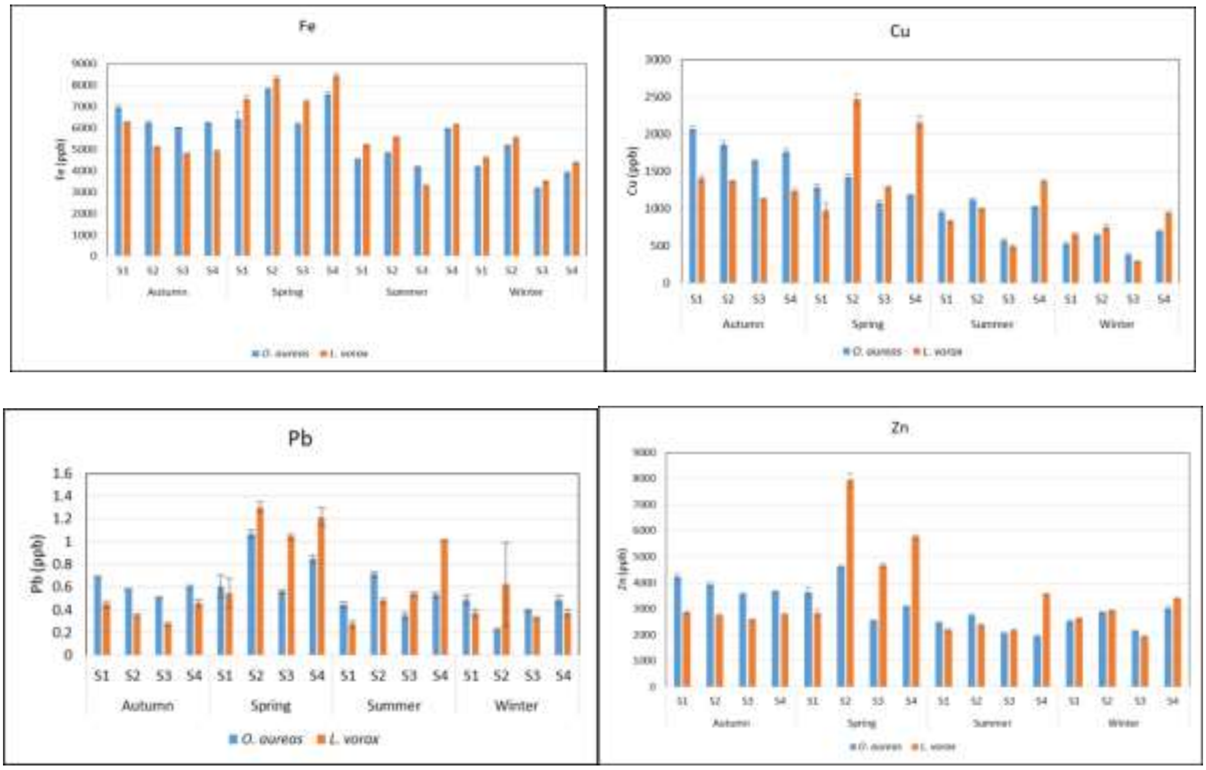


Figure 6. Iron, Copper, Zinc, Lead, Nickel, Cadmium, chromium Concentration rate µg /g in Clam



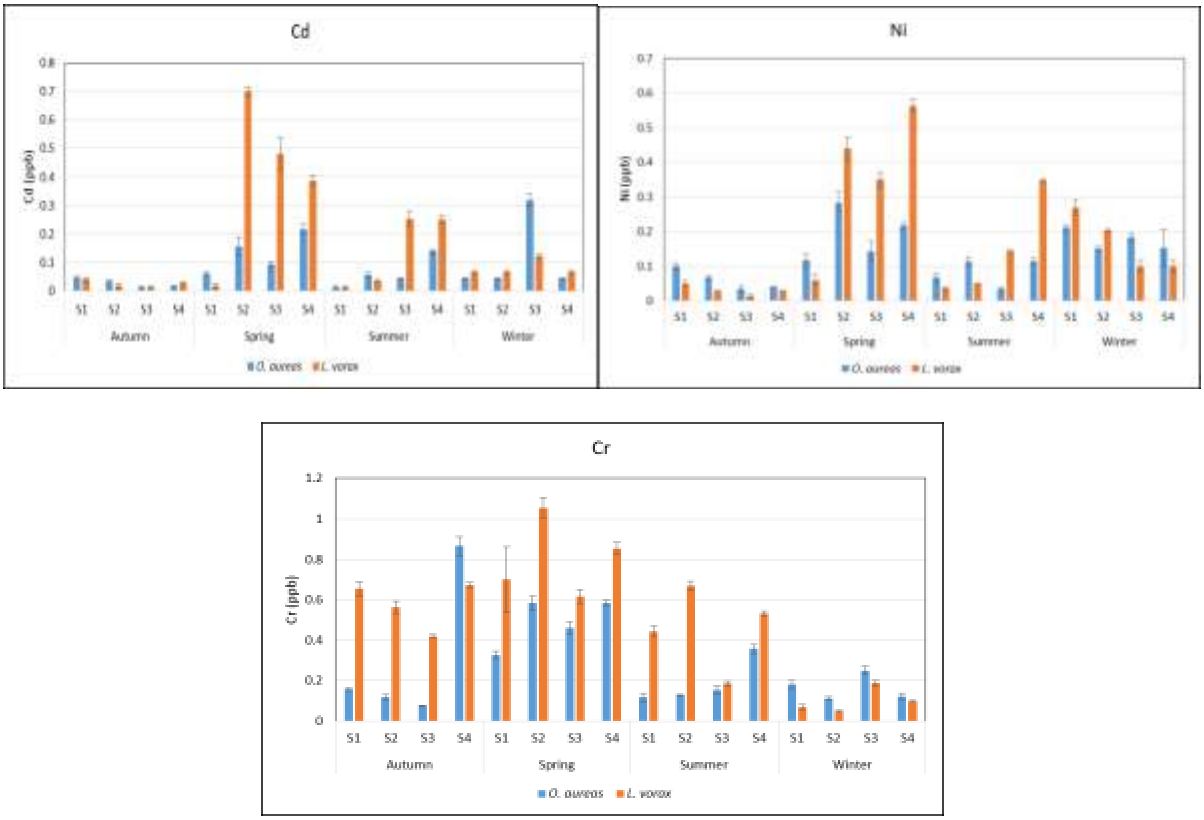


Figure 7. Iron, Copper, Zinc, Lead, Nickel, Cadmium, chromium Concentration rate µg /g in Fish

Conclusion:

The results of the physicochemical properties of Musayyib River branched from Euphrates river revealtemporal and spatial variations during the study period, as well as seasonal and site-specific fluctuations in heavy metal concentrations. Copper, Zinc &Iron concentration are higher in aquatic plant and clam and fish, and this study shows a clear transportation through food chains of river and bioaccumulation of heavy metals in aquatic biota as a potential source to pollution by heavy metals.

Acknowledgements

Authors are grateful to Department of Biology, College of science, and University of Babylon, Iraq for their support of this work.

Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Besides, the Figures and images, which are not ours, have been given the permission for re-publication attached with the manuscript.
- Authors sign on ethical consideration’s approval
- Ethical Clearance: The project was approved by the local ethical committee in College of Science, University of Babylon.

Authors' contributions statement:

This work was carried out in collaboration between all authors. A F K diagnosis the cases then collected the samples and doing the tests. J M S, wrote and edited the manuscript with revisions idea. P K,analysis the data with revisions idea.All authors read and approved the final manuscript.

References:

1. Al-Sareji O J, Grmasha R A, Salman J M .Street Dust Contamination by Heavy Metals in Babylon Governorate. Iraq J Eng Sci.T ech. 2021; 16(1) :455-469.https://jestec.taylors.edu.my/V16Issue1.htm
2. Ali H, Khan E. Bioaccumulation of non-essential hazardous heavy metals and metalloids in freshwater fish, Risk to human. Environ Chem Lett 2018; 1610-3653. https://doi.org/10.1007/s10311-018-0734-7
3- Arroyo P, Molinos-Senante M. Selecting Appropriate wastewater treatment technologies using a choosing-by advantages approach. Sci Total Environ. 2018; 625(1): 819–827. http://dx.doi.org/10.1016/j.scitotenv.2017.12.331
4. Ali H, Khan E, Ilahi I. Environmental Chemistry and Ecotoxicology of Hazardous Heavy Metals: Environmental Persistence, Toxicity, and Bioaccumulation. J Chem. 2019: 1-14. Article ID 6730305. https://doi.org/10.1155/2019/6730305
5.Brodin M, Vallejos M, Opedal MT, Area MC, Carrasco GC. Lignocelluloses as sustainable resources for production of Bioplastics -A Review. J Clean

Prod.2017; 162: 646-664. https://doi.org/10.54112/bcsrj.v2021i1.71
6. Li Y, Zhao B, Duan K, Cai J, Niu W, Dong X. Assessments of water-soluble inorganic ions and heavy metals in atmospheric dustfall and topsoil in Lanzhou, China. Int J Environ Res Public Health 2020;17(8): 29707. https://doi: 10.3390/ijerph17082970
7. Zhang JJ, Tong L, Huang Z W, Zhang H L, He MM, Dai XR, et al. Seasonal variation and size distributions of water-soluble inorganic ions and carbonaceous aerosols at a coastal site in Ningbo, China. Sci Total Environ. 2018; 639: 793–803. doi: 10.1016/j.scitotenv.2018.05.183.
8. Liu J, Gao M, Liang JN, Chen J. Characteristics and assessment of heavy metal pollution in spring atmospheric dust of an industrial park in Shaanxi Province. Res J Environ Sci. 2019; 32: 1195–1203. doi: 10.13198/j.issn.1001-6929.2019.02.06.
9. Varol M. Assessment of heavy metal contamination in sediments of the Tigris River (Turkey) using pollution indices and multivariate statistical techniques. J Hazard Mater. 2011; 195: 355–364. doi: 10.1016/j.jhazmat.2011.08.051.
10. Perumal K, Antony J, Muthuramalingam S. Heavy metal pollutants and their spatial distribution in surface sediments from Thondi coast, Palk Bay, South India. Environ Sci Eur. 2021; 33: 63. https://doi.org/10.1186/s12302-021-00501-2
11.Mkadmi Y, Benabbi O, Fekhaoui M, Benakkam R, Bjijou W. Study of the impact of heavy metals and physico chemical parameters on the quality of the wells and waters of the Holcim area (Oriental region of Morocco). J Mater Environ Sci. 2018; 9 (2): 672 -679 . https://doi.org/10.26872/jmes.2018.9.2.74
12. Anbuselvan N, Senthil Nathan D, Sridharan M. Heavy metal assessment in surface sediments of Coromandel Coast of India: Implication on marine pollution. MarPollut.Bull.2018; 131: 712–726. https://doi.org/10.1016/j.marpolbul.2018.04.074
13 Salman JM, Hassan FM, AbdulAmeer S H. A Study on the Fate of Some Heavy Metals in Water and Sediments in Lotic Ecosystems. Int J Chem Phys Sci. 2015; 4(2): 2319-6602. www.ijcps.org
14. Habeeb MA, Al-Bermani A K, Salman JM. Environmental study of water quality and some heavy metals in water, sediment and aquatic macrophytas in lotic ecosystem, Iraq. Mesop Environ J. 2015; 1(2): 66-84.
15. Al Zughaiby H H S, Jawad H J, Al Awadi J H H. The relationship between concentrations of some trace elements in the Euphrates River of Iraq. AIP Conf Proc .2020; 2290: 020044.https://doi.org/10.1063/5.0028128
16- . Hassan F M, Al-Obaidy A M J, Salman J M, Sara H. Abdulameer S H. Distribution of Polycyclic Aromatic Hydrocarbons in Water and Sediments in the Euphrates River, Iraq. Iraqi J Sci. 2019; 60(12): 2572-2582. DOI: 10.24996/ijs.2019.60.12.5
17. Salman J M, Al-ShammaryA A S . Monitoring Lotic Ecosystem by the Application of Water Quality Index (CCMEWQI). Baghdad Sci J.2020; 17(1): 23-27. https://doi.org/10.21123/bsj.2020.17.1.0023
18. Mackereth J H, Heron J, Talliny J F. Water analysis. some revised method for limnologists, Int Rev ges Hydrobiol Hydrogr. 1978; 36 :1-120.
19. APHA American Public Health Association. Standard methods for the examination of water and wastewater. 20th ed. Washington DC, USA, 2003. https://www.academia.edu/42904639/Standard_Methods_for_the_Examination_of_Water_and_Wastewater_23RD_Edition
20.APHA (American Public Health Association). Standard Methods for the Examination of Water and Wastewater 23th Edition, 800 I Street, NW, Washington DC, USA, 2017. https://www.pdfdrive.com/apha-standard-methods-for-the-examination-of-water-and-wastewater-d184521100.html
21. Turek A, Wieczorek K , Wolf W M . Digestion Procedure and Determination of Heavy Metals in Sewage Sludge—An Analytical Problem. Sustain. 2019; 11: 1753.http://dx.doi.org/10.3390/su11061753
22. Qadoori A H, Al –Tawash B S. Assessment of Some Heavy Metals in Water and Sediments Using Bio -Concentration Method of Al- Ma'ail River in Al - Kahla'a District, Maysan, Southern Iraq .2021; Iraqi Geol J. 2021; 54 (1D): 82 – 92 . https://doi.org/10.46717/igj.54.1D.7Ms-2021-04-27
23. Hassan FM, Salman, JM, Al-Nasrawi, S. Community Structure of Benthic Algae in a Lotic Ecosystem, Karbala Province Iraq, Baghdad Sci J. 2017; 14(4): 692-706. http://dx.doi.org/10.21123/bsj.2017.14.4.0692
24.Nashaat M R, Al-Bahathy I A A. Impact of Hindiya Dam on the Limnological Features of Euphrates River to the North of Babil Governorate, Iraq. Baghdad Sci J. 2022; 19(3): 447-459. http://dx.doi.org/10.21123/bsj.2022.19.3.0447
25. Maulood B K, Hassan F M. Physical and Chemical Characters of Mesopotamian Marshes: A Short Review. Chapter In book: Southern Iraq's Marshes, 2021; (pp.95-112)Springer -Nature Switzerland AG. https://doi.org/10.1007/978-3-030-66238-7_6
26. Ameen F, Albueajee A I, Hassan F M, Steven L. Stephenson S L, Douabul A A Z. Controlling Factors of Phytoplankton Productivity in Marshes in a Hot Climate with High Seasonal Variation. J Mar Sci Eng .2021; 9: 811. https://doi.org/10.3390/jmse9080811
27. El-Sheekh M M, Salman J M, GrmashaR A, Abdul-Adel,E , Saleh M M, Al-sareji O J. Infuence of Fe+2 on the Biomass, Pigments, and Essential Fatty Acids of Arthrospira platensis. Biomass Convers Biorefin. 2022. https://doi.org/10.1007/s13399-022-02470-9
28.Almamory A M J, Salman J M. Molecular Markers in Molluscs as Biomonitoring Species. Research Aspects in Biological Science. 2022; 3: 118-123.https://doi.org/10.9734/bpi/rabs/v3/15748D
29. Hassan F M , Saleh M M , Salman J M . A Study of Physicochemical Parameters and Nine Heavy Metals

in the Euphrates River, Iraq. J Chem. 2010; 7(3): 685-692. http://www.hindawi.com

30. Juned S ,Nagargoje B N ,Bhosle A B , Yannawar V B. Monitoring of Heavy Metals and Physico-Chemical Parameters of Soil, Near Sudha Dam Bhokar, Maharashtra. Am J Sci. 2018; 14 (5): 35-39.DOI:10.7537/marsjas140518.07
31. Peng K, Luo C, Lou L, Li X, Shen Z.Bioaccumulation of heavy metals by the aquatic plants Potamogeton pectinatus L. and Potamogeton malaianus Miq. and their potential use for contamination indicators and in wastewater treatment. Sci Total Environ. 2008 ; 392(1): 22-9.https://doi.org/10.1016/j.scitotenv.2007.11.032
32. Bai L, Liu X,Hu J. Heavy metal accumulation in common aquatic plants in rivers and lake in the Taihu basin. Int J Environ Res Public Health. 2018; 14; 15(12): 2857. https://doi.org/10.3390/ijerph15122857
33. Skorbiłowicz E , Skorbiłowicz M , Tarasiuk U , Magdalena Korzińska M. Cadmium, Chromium, and Cobalt in the Organs of *Glyceria maxima* and Bottom Sediments of the Pisa River and Its Tributaries (Poland) .Int J Environ Res Public Health 2021 ; 28;18(19):10193 .https://doi.org/10.3390/ijerph181910193
34. Zeng J, Han G, Zhang S, Zhang Q. Suspended Sediments Quality Assessment in a Coastal River: Identification of Potentially Toxic Elements. Int. J Environ. Res Public Health 2022; 19(7): 4293.https://doi.org/10.3390/ijerph19074293
35. Wang J, Liu G, Wu H, Zhang T, Liu X, Li W.Temporal-spatial variation and partitioning of dissolved and particulate heavy metal(loid)s in a river affected by mining activities in Southern China. Environ Sci Pollut Res. 2018; 25(10): 9828-9839. https://doi.org/10.1007/s11356-018-1322-x
36. Nag R, O'Rourke SM, Cummins E. Risk factors and assessment strategies for the evaluation of human or environmental risk from metal(loid)s - A focus on Ireland. Sci Total Environ. 2022: 802: 149839. https://doi.org/10.1016/j.scitotenv.2021.149839
37. Nag R, O'Rourke SM, Cummins E. A GIS study to rank Irish agricultural lands with background and anthropogenic concentrations of metal(loid)s in soil. Chemosphere 2022; 286(Pt 3):131928. https://doi.org/10.1016/j.chemosphere.2021.131928
38. Salman J M, Hassan F M, Abdulameer S H. Qualitative and Quantitative study of Epipelion algal community in Euphrates River (Al-Hussainya), Karbala Province-Iraq. Int J aquat sci. 2013; 9(1): 30-37. and anthropogenic concentrations of metal(loid)s in soil.R, Chemosphere 2022; 286(Pt 3): 131928. https://doi.org/10.1016/j.chemosphere.2021.131928
39. Al-Edani T Y, Al-Tameemi H J, JasimZ F. Phytoremediation of Heavy Metals (Cd, Cu, Fe, and Pb) by Using Aquatic Plants in Shatt Al-Arab River. J Eng Technol. 2019; 37(3C): 365-369. http://dx.doi.org/10.30684/etj.37.3C.10
40. Al-Samarrai S Y Karaghool H AKH, Abdulridha A, Al-Ansari N, Salman J M, Al-Sareji OJ .Minimizing the Fluoride Load in Water Using the Electrocoagulation Method: An Experimental Approach. Environ. – MDPI , 2022; 9 (3): 38. https://doi.org/10.3390/environments9030038
41. Saeed S I, Ahmed RZT, Grmasha R A, Alenezi S M, Salman J M, Al-Sareji O J, et al.Heavy metal pollution removal from water using a cost-effective bio-adsorbent. IOP Conf. Ser: Mater Sci Eng. 2021; 1058(10): 012013. doi:10.1088/1757-899X/1058/1/012013
42. Kadeem ZJ , Hassan FM , Al Obaidy AHMJ . Monitoring of Phytoplankton in the Artificial Lake: Comparison Study. IOP Conf. Ser: Earth Environ Sci.2021; 779: 012125. doi:10.1088/1755-1315/779/1/012125
43. El Nemr A ,El-Said GF,Ragab S, Khaled A, El-Sikaily A. The distribution, contamination and risk assessment of heavy metals in sediment and shellfish from the Red Sea coast, Egypt .Chemosphere , 2016; 165: 369-380. https://doi.org/10.1016/j.chemosphere.2016.09.048
44. GaoY,Wang R ,LiXuebinY,Yueming D, GJian J, Feng L, et al. Trophic transfer of heavy metals in the marine food web based on tissue residuals. Sci Total Environ.2021; 772: 145064. https://doi.org/10.1016/j.scitotenv.2021.145064
45. Mirza NNA, Nashaat MR. Abundance, Diversity and Distribution of Mollusca in the Gharaf River, Southern Iraq. Iraqi J Sci. 2019; 60 (3): 469-485. DOI: 10.24996/ijs.2019.60.3.7
46. Merza F A. Diversity of Mollusca in some sites of Euphrates River. J Phys Conf Ser. 2021; 1879: 022049. doi:10.1088/1742-6596/1879/2/022049
47. Canli M, Atli G. The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb& Zn) levels and the size of six Mediter-ranean fish species. Environ Pollut. 2003; 121: 129–136. https://doi.org/10.1016/s0269-7491(02)00194-x
48. Türkmen A, Türkmen M, Tepe Y and Akyurt İ. Heavy metals in three commercially valuable fish species from İskenderun Bay, Northern East Mediterranean Sea, Turkey. Food Chem. 2005; 91(1): 167–172. http://dx.doi.org/10.1016/j.foodchem.2004.08.008
49. Al-Kazaghly R F, Hamid M, Ighwela KA. Bioaccumulation of some Heavy Metals in Red mullet (*Mullus barbatus*) and Common pandora (*Pagellus erythrinus*) in Zliten Coast, Libya. J Kelaut Perikan Terap. 2021; 13(1): 81–86. http://doi.org/10.20473/jipk.v13i1.2203750.
50. Rajeshkumar S , Li X. Bioaccumulation of heavy metals in fish species from the Meiliang Bay, Taihu Lake, China. Toxicol Rep. 2018; 5 :288–295. https://doi.org/10.1016/j.toxrep.2018.01.007
51. Alshkarchy S S , Raesen AK , Najim SM. Effect of heavy metals on physiological and histological status in liver of common carp Cyprinus carpio, reared in cages and wild in the Euphrates River, Babil / Iraq. IOP Conf Ser: Earth Environ Sci. 2021; 779: 012066. doi:10.1088/1755-1315/779/1/012066
52. Alasadiy Y D K. Evaluation of parasitic infection in two species of fishes from Euphrates river passing

through Al-Muthanna Province. J Phys Conf Ser. 2019; 1279: 012030. doi:10.1088/1742-6596/1279/1/012030
53. Athab ZH, Halbus AF, Abbas, AS,Salman J M ,Lafta ,AJ. Enhanced Macroporous Cationic Chitosan Hydrogel by Freezing and Thawing Method with Superadsorption Capacity for Anionic Dyes. J Polym Environ. 2022. 30(6): 12-17. https://doi.org/10.1007/s10924-022-02462-w
54. Aziz F H, Rasheed R O. Heavy metals in water, fishes and sediments in Derbendikhan reservoir, Kurdistan Region-Iraq. Zanco J Pure Appl Sci. 2017; 29 (3): 19-27 http://dx.doi.org/10.21271/ZJPAS.29.3.3
55. Rasheed RO. Assessment of some Heavy Metals in Muscle Tissue of Silurus triostegus from Derbendikhan Reservoir, Kurdistan Region –Iraq. Rafidain J Sci. 2012; 23(1): 11-18. doi:10.33899/rjs.2012.29081

تقدير بعض العناصر الثقيلة ومصيرها وانتقالها في مياه ورواسب وبعض احياء نهر قناة المسيب, محافظة بابل, العراق

اشواق فالح خزعل [1] **جاسم محمد سلمان**[2] **باترك كوت**[3]

[1]قسم علوم الحياة,كلية العلوم للبنات,جامعة بابل,بابل,العراق.
[2]قسم علوم الحياة,كلية العلوم, جامعة بابل, بابل,العراق.
[2]مركز بحوث ودراسات البيئة, جامعة بابل,بابل,العراق.
[3]معهد بحوث تقنيات البيئة والاستدامة, جامعة ليفربول جون موريس, ليفربول, المملكة المتحدة.

الخلاصة:

تناولت هذه الدراسة تقدير سبعة عناصر ثقيلة (الحديد والنحاس والزنك والرصاص والنيكل والكادميوم والكروم) في الماء (الطور الذائب والدقائقي) والرواسب وبعض الكائنات الحية المائية بما في ذلك نوعان من النباتات المائية (*Ceratophyllum* *Phragmites australis&demersum*) و نوع واحد من المحار (*Psedontopeses euphratics*) ونوعان من الأسماك (*Leuciscus vorax&Oreochromis aureus*) في أربعة مواقع داخل قناة مشروع المسيب / فرع من نهر الفرات ، بابل ، وسط العراق ويهدف ذلك لبيان تركيز هذه العناصر ومصيرها واليات انتقالها خلال السلسلة الغذائية في هذا النظام المائي الجاري ، أيضًا تم قياس بعض الخصائص الفيزيائية والكيميائية لمياه القناة ، مثل درجة حرارة الماء والاس الهيدروجيني والتوصيلية الكهربائية (EC) والملوحة و المواد الصلبة الذائبة الكلية (TDS) و المواد الصلبة العالقة الكلية (TSS) والأكسجين المذاب (DO) والمتطلب الاحيائي للاوكسجين (BOD5).وكان الترتيب للعناصر المدروسة في الطور الذائب من الماء هو: - Cd<Cr<Pb<Ni<Cu<Fe<Zn اذ سجل عنصر الزنك أعلى معدل في الموقع الثاني لموسم الربيع بينما سجل عنصر الكادميوم أقل معدل في الموقع الأول لموسم الربيع. وفي الطور الدقائقي منه ترتبت العناصر بالشكل الاتي: Cd<Cr<Pb<Ni<Fe<Cu<Zn والتي سجل فيهاعنصر الزنك أعلى معدل في الموقع الثاني لموسم الربيع بينما سجل عنصر الكادميوم أقل معدل في الموقع الرابع لموسم الربيع وترتبت العناصر تحت الدراسة في الرواسب بالصيغة الاتية : Cr<Cd<Ni<Pb<Fe<Cu<Zn وسجل عنصر الزنك أعلى معدل في الموقع الثاني لموسم الربيع بينما سجل عنصر الكروم أقل معدل في الموقع الثاني للربيع وفي النبات المائي*C. demersum*كان تدرجها اخذ الشكل الاتي: Cd<Ni<Cr<Pb<Cu<Fe<Zn سجل عنصر الزنك أعلى معدل في الموقع الرابع لموسم الشتاء بينما سجل عنصر الكادميوم أقل معدل في الموقع الأول لموسم الخريف في*P. australis* كما في الصيغة: Cr<Ni <Cd<Pb<Cu<Fe<Zn سجل عنصر الزنك أعلى معدل في الموقع الثاني لموسم الربيع بينما سجل عنصر الكروم أقل معدل في الموقع الثاني لموسم الربيع. اما في المحار فقد كان ترتيبها كالاتي: Cr<Cd<Pb<Ni<Cu<Fe<Zn ، سجل عنصر الزنك أعلى معدل في الموقع الثاني لموسم الربيع بينما سجل الكروم أدنى قيمة في الموقع 3 خلال شتاء 2021 وفي أنواع الأسماك (*O. aureus*) كان ترتيب Ni<Cd<Cr<Pb<Cu<Zn<Fe. سجل عنصر الحديد أعلى معدل في الموقع 2 في ربيع عام 2021 بينما سجل عنصر الحديد أقل معدل كان Ni في الموقع 2 للربيع و سجل عنصر الحديد أعلى معدل في الموقع الأول لموسم الصيف بينما سجل النيكل قيم منخفضة في الموقع الرابع في ربيع 2021.

الكلمات المفتاحية: احياء مائية، نهر الفرات، عناصر ثقيلة, نظام مائي جاري, رواسب, نوعية المياه.