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Heavy Metals in water at Al-Delmaj Marsh, Al-Kut Province, Iraq

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Abstract:

Water samples were taken seasonally from February to November 2018, at ten stations in Al-Delmaj marsh, the stations were selected to cover most marsh area, the regional and seasonal study of seven heavy metals Cd, Cr, Cu, Zn, Ni, Pb, Fe were determined in Dissolved and Particulate phases. The results showed that there were variations in the values of the elements, ranged as follows: Cd: Diss. 0.123 - 0.182 µg/l, Par. 0.129 - 0.195 µg/g, Cr: Diss.1.207-1.429 µg/l, Par. 1.276 - 1.435 µg/g, Cu: Diss. 0.228 - 0.571 µg/l ,Par. 0.237 - 0.295 µg/g, Zn: Diss. 1.611 - 2.339 µg/l, Par. 1.843 – 2.648 µg/g, Ni:Diss.1.419 - 1.767 µg/l, Par.1.458 - 1.933 µg/g, Pb: Diss. 3.105- 3.903 µg/l, Par. 3.332 - 4.268 µg/g, Fe: Diss. 7.166 - 9.313 µg/l, Par. 7.964 - 9.850 µg/g, the recorded concentrations of heavy elements are very important to know the locations of pollution, its percentage, causes, and sources.

Key Words: Heavy metals, waters, Al-Delmaj Marsh, Iraq

Introduction

There are several materials or energy that are introduced directly or indirectly to the aquatic environment because of various human activities, and that lead to harmful effects on human health and aquatic organisms and lead to disruptive kinds of water activities. Otherwise, a change in the properties of water will lose its validity for use in different purposes (GESAMP, 1993). Therefore, the study of the pollution of the southern marshes is one of the important studies in determining the origin of pollution and its percentage in this region (Al-Atbee,2018). The most important and harmful pollutants in the aquatic environment are petroleum hydrocarbons and heavy elements that affect water in its dissolved phase, particulate, organisms, and sediments (Al-Saad *et al.*,2009). Heavy metals with high atomic weights and high density include (Ni, Pb, Cd, Cu, Fe, Cr, S, P, Zn, As, Se, Mo, Co, Sr, Br, N). The proportions of those elements vary depending on the quality of the parent rock. These elements are studied because their distribution and concentrations help to know the sources of pollution in water systems and soils (Al-Heijuje, 2014, khuzaie, 2015). These elements enter the aquatic environments through natural and other industrial sources (Mustafa, 1985, Abaychi and Al-Saad, 1988, Al-Khafaji, 1996). Natural sources including dusty storms, weathering, erosion. Whereas industrial sources including waste disposal, industrial discharge, petroleum and chemical industries (FAO, 1994).

These elements are one of the most dangerous inorganic pollutants, which have spread in the environment since the beginning of the industrial revolution, and their significant accumulation leads to the transformation of more toxic complex compounds to remain for a long time in the environment causing an imbalance of the ecosystem, as well as, increasing their rates will damage the soil characteristics and the destruction of biological diversity in the environment. Water pollution with heavy metals is receiving in the world today (Miretzky *et al.*, 2004). Heavy elements pollution become a major environmental problem, due to their toxicity, non-degradable and constant nature. This leads to their aggregation in plants, microorganisms and other aquatic organisms that are transmitted to humans through the food chain, which leads to multiple health problems (Varol and Sen,2012). Recently, concentrations of heavy elements that exceeded the allowed limits in waters caused health problems and its impact on the aquatic ecosystem (Ndimele and Jimoh, 2011). These elements are essential and necessary to sustain the life of living organisms such as copper, zinc, and iron, which play main roles in the functioning of enzyme systems. On the other hand, higher concentrations become toxic. The other group of elements are non-essential, it contains elements that pollute the environment and harm its revival even when it exists at low levels.

Materials and Methods

Water samples were collected seasonally, from February to November 2018. This study was carried out involving 10 fixed stations as shown in Fig. (1). station 1, station 2 before feeding, station 2 after feeding, station 3, station 4, station 5 before discharge, station 5 after discharge, station 6, station 7, station 8, in the Al-Delmaj marsh in Al-Diwaniya, the samples sites were selected based on field surveys.

Water samples: Water samples 10L were collected from each station at least 20-30 cm under the water surface, at the middle of the station.

Water samples 10 L were filtered as soon as possible through pre-washed 0.5N HCl and pre–weighted Millipore filters paper 0.45 µm pore size, the retained matter on the filters were considered as a particulate phase while the filtrate water was considered as a dissolved phase. Then, the filtrate was pre – concentrated according to Riley and Taylor (1968) method, using chelating ion-exchange resin (Amberlite resin) about 10L of the filtrate was pass through 1.5 cm diameter ion-exchange column which was filled with the resin to approximate depth 12 cm. The resin was packed freshly and reactive before use by passing 30 ml of 2N HNO_3, then add 100 ml of deionized water, and 30 ml of 3N NH_4OH, then 100 ml of deionized water. The filtrate water allowed passing through the column with a flow rate of about 8 ml/min, the bounded heavy metals were eluted using 50 ml of 2N HNO_3. The elutes were collected in 100 ml clean teflon beaker, put on a hot plate at 70° C until the sample volume became less than 25 ml, then the sample was completed to 25 ml with deionized water and placed in tightly stopper polyethylene vials to be ready for analysis of the metals using Flame Atomic Absorption Spectrophotometer

After filtration, the filters were dried in the oven at 60 C° until dry and then weighted, to extract the particulate heavy metals used 30 ml HCl 0.5 N overnight in an orbital shaker with 300 rpm, then the solution was centrifuged at 5000 rpm for 20 minutes, the supernatant was filtered using filter paper (Watman No. 1). The filtrate was stored in tightly stopper polyethylene vials to be ready for analysis (Al-Hejuje *et al.*, 2017).

Results and Discussion:

Seven heavy metals Cd, Cr, Cu, Ni, Zn, Pb, Fe, have been analyzed; the measured concentrations of these pollutants in water samples are shown in tables (1-7), as follows:

Cadmium (Cd): the concentration of the element has increased in the past decades due to the increase in human activities; the danger of the increase is the formation of strong complex with carcinogenic effects on humans (Goering *et al.*, 1994). It is one of the most toxic elements after the mercury (Krajne, 1987, and Agha *et al.*, 2012).

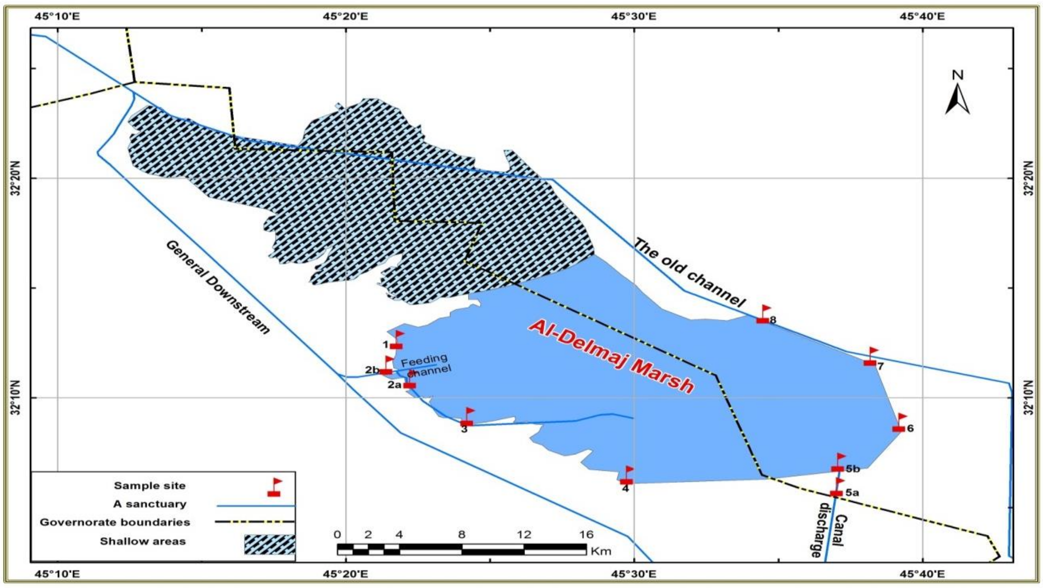

Figure (1): Map of Al-Dalmaj marsh showing sampling locations

Table (1), Showed that Cd in the particulate phase in the summer season, was the highest value reached 0.174 µg/g in station 5 before discharge, the lowest value 0.037 µg/g in station 2 before feeding at the mean 0.129 µg/g for all stations. In the autumn season, the highest value of the particulate phase report 0.194 µg/g in station 2 after feeding and lowest value 0.112 µg/g in station 3 and mean 0.147 µg/g for all stations. The highest value in the winter season reached 0.186 µg/g in station 2 after feeding and 5 after discharge, the lowest value 0.064 µg/g in station 2 before feeding and mean 0.147 µg/g for all stations, In the spring season, the highest value reached 0.908 µg/g in station 2 after feeding, the lowest value 0.044 µg/g in station 2 before feeding and mean 0.195 µg/g for all stations. the difference in the Cadmium values which are few in study stations, the highest values were found in station 2 after feeding in the autumn season reached 0.194 µg/g. The lowest value appeared in the summer season of station 2 before feeding reached 0.037 µg/g. The highest value of the dissolved phase of the summer season, reached 0.811 µg/l in station 2 after feeding, while the lowest value 0.043 µg/l in station 2 before feeding and a mean 0.182 µg/l for all stations. The highest value in the autumn season reached 0.328 µg/l in station 2 after feeding; the lowest value 0.111 µg/l in station 8 and mean 0.172 µg/l for all stations. In the winter season, the highest value was reached 0.167 µg/l in station 3; the lowest value was 0.055 µg/l in station 2 before feeding and mean 0.123 µg/l for all stations. The highest value in the spring season reached 0.176 µg/l in station 5 before discharge the lowest value 0.044 µg/l in station 2 before feeding and mean 0.130 µg/l for all stations. The highest value that appeared in the summer reached 0.811 µg/l in station 2 after feeding; the lowest value showed in the summer season reached 0.044 µg/l in station 2 before feeding.

Chrome (Cr): is transported in water systems, by the integration of the holders to be associated with the strongest elements with the rock installation. Chromium is present in freshwater with a concentration less than 0.0006 gm/l and in seawaters, less than 0.005 gm/l. Increasing its concentration in water leads to its mixing with industrial waste, and excessive concentration than 0.05 gm/l may cause cancer (Alloway and Ayres, 1997).

The particulate phase in the table (2) showed that the highest value in the summer season reached 2.252 µg/g in station 1, the lowest value reached

0.703 µg/g in station 7, and mean 1.295 µg/g for all stations. In the autumn season, the highest value reached 2.525 µg/g in station 1, the lowest value 0.645 µg/g in station 8 and mean 1.340 µg/g for all station, In the winter season, the highest value reached 2.632 µg/g in station 1 and the lowest value 0.72 µg/g in station 7 and mean 1.435 µg/g for all stations, In the spring season, the highest value reached 2.323 µg/g in station 1, the lowest value 0.632 µg/g in station 7 and mean 1.276 µg/g for all station. There are very few differences in the rates of the element in the different seasons and that the highest values appeared in all seasons in station 1, and that the lowest values appeared in the 7 and 8 stations with very little difference in the seasons.

While in the dissolved phase, the highest value in the summer season reached 2.111 µg/l in station 1, the lowest value reached 0.529 µg/l in station 7, and mean 1.207 µg/l) for all stations. In the autumn season, the highest value reached 2.121 µg/l in station 2 after feeding; the lowest value 0.852 µg/l in station 8 and mean 1.379 µg/l for all stations. Whereas the highest value in the winter season reached 2.544 µg/l) in station 1, the lowest value 0.628 µg/l in station 7 and mean 1.343 µg/l for all stations. In the spring season, the highest value reached 2.342 µg/l in station 1, the lowest value 0.717 µg/l in station 7 and mean 1.429 µg/l for all stations. There are very few variations in the rates of values among different seasons, the highest values appear in station 1, and the lowest values among the seasons appeared in station 7 in the summer season.

Copper (Cu): is found in nature with very low concentrations, and all types of soils, where it enters into the composition of chlorophyll and the installation of enzymes in plants. It is one of the micro-ocular nutrients which easily assembled by waters (Jaagumagi, 1990 and Agah *et al.*, 2012).

Showed Table (3), the analyzes of Cu, the highest value of the element in the particular phase during summer season samples reached 0.342 µg/g in station 2 before feeding, the lowest value was 0.185 µg/g in station 8 and mean 0.258 µg/g for all stations. While the highest value in the autumn season was 0.334 µg/g in station 5 after discharge, the lowest value 0.217 µg/g in station 7 and mean 0.272 µg/g for all stations, in the winter season, the highest value was 0.39 µg/g in station 2 before feeding, the lowest value reached 0.203 µg/g in station 8 and mean 0.295 µg/g for all stations, while in the spring season the highest value 0.314 µg/g in station 2 before feeding, the lowest value 0.152 µg/g in station 8 and mean 0.237 µg/g for all stations. There is a significant decrease in the concentrations of the element in the particulate phase in all stations and seasons, the highest value appeared in the winter season of station 2 before feeding reached 0.39 µg/g, the lowest value appeared in the spring season reached 0.152 µg/g) in station 8.

The highest values of the dissolved phase concentrations in the summer season was reached 0.304 µg/l in station 2 before feeding, the lowest value 0.143 µg/l in station 8 and mean 0.228 µg/l for all stations, while in the autumn season, the highest value reached 1.933 µg/l in station 5 before discharge, the lowest value was 0.145 µg/l in station 8 and mean 0.571 µg/l for all stations, while the highest value of the winter season was reached 0.376 µg/l in station 2 before feeding, the lowest value 0.162 µg/l in station 8 and mean 0.262 µg/l for all stations, In the spring season, the highest value 0.378 µg/l in station 2 before feeding, the lowest value 0.197 µg/l in station 8. There is a decrease in the values of the element in the dissolved phase for all seasons, the highest value appeared in the autumn season reached 1.933 µg/l in station 5 before discharge, and the lowest value appeared in the summer season reached 0.143 µg/l in station 8.

Table (1): Seasonal variations in concentrations of (Cd µg/g in Particulate and µg/l in dissolved) from the study stations

Stations	Summer		Autumn		Winter		Spring	
	Part.	Disso.	Part.	Disso.	Part.	Disso.	Part.	Disso.
1	0.165	0.134	0.124	0.135	0.184	0.163	0.143	0.167
2 before	0.037	0.043	0.166	0.223	0.064	0.055	0.044	0.044
2 after	0.146	0.811	0.194	0.328	0.186	0.103	0.908	0.154
3	0.156	0.135	0.112	0.288	0.174	0.167	0.143	0.165
4	0.103	0.103	0.122	0.123	0.114	0.106	0.105	0.104
5 before	0.174	0.127	0.143	0.13	0.155	0.143	0.137	0.176
5 after	0.115	0.144	0.185	0.128	0.186	0.157	0.146	0.105
6	0.126	0.103	0.115	0.133	0.124	0.107	0.103	0.126
7	0.127	0.103	0.127	0.127	0.137	0.115	0.104	0.126
8	0.131	0.119	0.136	0.111	0.149	0.119	0.124	0.137
Mean	0.129	0.182	0.147	0.172	0.147	0.123	0.195	0.130

Table (2) Seasonal variations in concentrations of (Cr µg/g in Particulate and µg/l in dissolved) from the study stations

Stations	Summer		Autumn		Winter		Spring	
	Part.	Disso.	Part.	Disso.	Part.	Disso.	Part.	Disso.
1	2.252	2.111	2.525	1.982	2.632	2.544	2.323	2.342
2 before	1.415	1.317	1.544	1.853	1.627	1.515	1.426	1.43
2 after	1.584	1.385	1.645	2.121	1.647	1.535	1.493	1.624
3	1.003	1.001	1.212	1.032	1.127	1.031	1.004	1.026
4	1.405	1.427	1.202	1.422	1.627	1.595	1.486	1.426
5 before	1.324	1.305	1.365	1.362	1.424	1.334	1.313	1.350
5 after	1.366	1.290	1.314	1.351	1.461	1.312	1.319	1.375
6	0.766	0.706	1.026	0.891	0.923	0.85	0.747	0.853
7	0.703	0.529	0.928	0.931	0.72	0.628	0.623	0.717
8	1.133	1.005	0.645	0.852	1.163	1.091	1.026	1.155
Mean	1.295	1.207	1.340	1.379	1.435	1.343	1.276	1.429

Table (3) Seasonal variations in concentrations of (Cu µg/g in Particulate and µg/l in dissolved) from the study stations

Stations	Summer		Autumn		Winter		Spring	
	Part.	Disso.	Part.	Disso.	Part.	Disso.	Part.	Disso.
1	0.256	0.214	0.266	0.212	0.285	0.245	0.222	0.266
2 before	0.342	0.304	0.253	0.281	0.39	0.376	0.314	0.378
2 after	0.202	0.226	0285	0.326	0.303	0.265	0.245	0.209
3	0.267	0.287	0.312	0.266	0.312	0.3	0.291	0.287
4	0.255	0.234	0.261	0.249	0.286	0.266	0.249	0.288
5 before	0.245	0.168	0.288	1.933	0.267	0.258	0.233	0.266
5 after	0.307	0.218	0.334	1.763	0.315	0.225	0.186	0.303
6	0.257	0.243	0.254	0.313	0.287	0.265	0.233	0.263
7	0.269	0.247	0.217	0.227	0.303	0.266	0.253	0.3
8	0.185	0.143	0.256	0.145	0.203	0.162	0.152	0.197
Mean	0.258	0.228	0.272	0.571	0.295	0.262	0.237	0.275

Nickel (Ni): is a non-toxic ingredient in general, but fetched up may become toxic, especially if it is powder. It may easily move in air and water, so it can cause kidney problems and skin allergies (UNESCO, 1996, WHO, 1999). The results of the Ni analyzes in the table (4), showed that the highest value Ni in the Particulate phase appeared in the summer season reached 2.984 µg/g in station 4, and it's the lowest value reached 1.112 µg/g- in station 6 and mean 1.702 µg/g for all stations, while in the autumn season the highest value 2.032 µg/g in station 2 after feeding, and the lowest value reached was 1.125 µg/g in station 7 and mean 1.458 µg/g for all stations. Whereas in the winter season, the highest value reached 4.032 µg/g in station 4, the lowest value 0.929 µg/g in station 2 after feeding and mean 1.933 µg/g for all stations. While in the spring season, the highest value reached 3.232 µg/g in station 4, the lowest value reached 0.845 µg/g in station 2 after feeding and mean 1.590 µg/g for all stations. There are variations in the particulate phase concentrations of the nickel, the highest value appeared in the winter season in station 4 reached 4.032 µg/g and the lowest value in the spring season in station 2 after feeding and mean 0.845 µg/g.

The values of the dissolved phase of the element, the highest value in the summer season reached 3.133 µg/l in station 4; the lowest value was 0.047 µg/l in station 7 and mean 1.419 µg/l for all stations. In the autumn season, the highest value reached 2.647 µg/l in station 4, the lowest value 0.946 µg/l in station 2 after feeding and mean 1.473 µg/l for all stations. Whereas in the winter season, the highest value 3.371 µg/l in station 4, the lowest value (0.95 µg/l in station 2 after feeding and mean 1.693 µg/l for all stations. In the spring season, the highest value reached 3.022 µg/l in station 4, the lowest value reached 1.123 µg/l in station 7 and mean 1.767 µg/l for all stations. The highest value appeared in the winter season in station 4 reached 3.371 µg/l, while the lowest value appeared in the summer season in station 7 reached 0.047 µg/l.

Lead (Pb): is the most important heavy element, of being the most toxic elements. (Qader and khazei, 2004). There are low concentrations in natural soils, as it is concentrated in most soils between 10 – 67 µg/Kg, but increasing from the normal level, because of industrial activities carried out by humans. (Al-Saad and Selman, 2006). The results of the analyzes for this element, in the table (5), showed that the particulate phase of the element has the highest value in the summer season reached 4.567 µg/g in station 2 before feeding, and the lowest value was 2.314 µg/g in station 8 and mean 3.332 µg/g for all stations. While in the autumn season, the highest value 5.319 µg/g in station 2 after feeding, the lowest value was 3.163 µg/g in station 4 and mean 3.713 µg/g for all stations, whereas in the winter season, the highest value reached 5.644 µg/g in station 2 before feeding, the lowest value was 3.627 µg/g in station 5 before discharge and mean 4.268 µg/g for all stations. In the spring season, the highest value reached 4.252 µg/g in station 2 before feeding; the lowest value was 2.767 µg/g in station 6 and mean 3.367 µg/g for all stations. The highest value appeared in the winter season in station 2 before feeding reached 5.644 µg/g, while the lowest value appeared in the summer season in station 8 reached 2.314 µg/g.

In the dissolved phase, the highest value of the summer season reached 3.802 µg/l in station 4, the lowest value was 2.439 µg/l in station 7 and mean 3.105 µg/l for all stations. While in the autumn season, the highest value reached 4.542 µg/l in station 2 after feeding, the lowest value was 2.429 µg/l in station 7 and mean 3.300 µg/l for all stations. Whereas in the winter season, the highest value reached 5.393 µg/l in station 2 before feeding, the lowest value was 3.43 µg/l in station 7 and mean 3.903 µg/l for all stations. In the spring season, the highest value reached 4.745 µg/l in station 2 before feeding; the lowest value was 2.457 µg/l in station 8 and mean 3.617 µg/l for all stations. The highest values of the element in station 2 before feeding in the winter season reached 5.393 µg/l, whereas the lowest values reached 2.429 µg/l in station 7 of the autumn season.

Zinc (Zn): is high in industrial waste areas, and is found as a soluble substance. Its existence presents one of the primary inorganic sources of pollution, the dumping of heavy wastewater resulting from human uses in addition to the decomposition of organic matter and animal waste. These are sources of zinc in rivers. Zinc is characterized by the survival of the solution and long-distance transmission without precipitation, (Riyadh, 2006). The results of the analyzes for this element, showed in the table (6), the highest value in the particulate phase in the summer season reached 3.322 µg/g in station 8, the lowest value was 1.002 µg/g in station 1 and mean 2.193 µg/g for all stations, while in the autumn season, the highest value reached 4.469 µg/g in station 4, the lowest value was 1.105 µg/g in station 1 and mean 2.648 µg/g for all stations, In the winter season, the highest value reached 3.98 µg/g in station 8, the lowest value was 1.103 µg/g in station 1 and mean 2.436 µg/g for all stations, whereas in the spring season, the highest value reached 2.673 µg/g in station 8, the lowest value was 1.207 µg/g in station 7 and mean 1.843 µg/g for all stations. The highest values appeared in the autumn season of station 4 reached 4.469 µg/g, whereas the lowest values appeared in the summer season in station 1 reached 1.002 µg/g.

In the dissolved phase results showed that the highest value of the summer season reached 2.004 µg/l in station 2 after feeding and 6, the lowest value was 1.128 µg/l in station 7 and mean 1.611 µg/l for all stations, while in the autumn season, the highest value reached 2.313 µg/l in station 6, the lowest value was 1.125 µg/l in station 3 and mean 1.749 µg/l for all stations, whereas the highest value of the winter season reached 3.877 µg/l in station 8, the lowest value was 1.35 µg/l in station 4 and mean 2.339 µg/l for all stations, In the spring season, the highest value 3.542 µg/l in station 8, the lowest value was 1.023 µg/l in station 1 and mean 2.209 µg/l for all stations. There were few variations in the concentrations values between the stations and seasons, the highest value appeared in the winter season of the station 8 reached 3.877 µg/l, the lowest values appeared in the spring season in the station 1 reached 1.023 µg/l.

Iron (Fe): is one of the important elements found in soils and biology. It is essential to the growth of plants and animals, but it becomes harmless, as it oxidized automatically. Results in table (7), showed that the highest value in the Particulate phase in the summer season reached 14,735 µg/g in station 2 before feeding, the lowest value 4.245 µg/g in station 5 before discharge and mean 8.523 µg/g for all stations. While in the autumn season, the highest value reached 14.271 µg/g in station 2 after feeding, the lowest value was 4.581 µg/g in station 7 and mean 9.412 µg/g for all stations. In the winter season, the highest value reached 17.265 µg/g in station 2 before feeding; the lowest value was 5.311 µg/g in station 6 and mean 9.850 µg/g for all stations. Whereas in the spring season, the highest value reached 14.255 µg/g in station 2 before feeding, the lowest value was 3.93 µg/g in station 6 and mean 7.964 µg/g for all stations. The highest value of the particulate phase occurred in the winter season in station 2 before feeding reached 17.265 µg/g, while the lowest value occurred in the spring season in station 6 reached 3.93 µg/g.

The results of the analyzes of the dissolved phase, showed that the highest value in the summer season reached 12.546 µg/l in station 2 before feeding, the lowest value was 3.675 µg/l in station 6 and mean 7.166 µg/l for all stations. While in the autumn season, the highest value reached 15.161 µg/l in station 2 after feeding, the lowest value was 3.212 µg/l in station 6 and mean 8.180 µg/l for all stations.

Table (4): Seasonal variations in concentrations of (Ni µg/g in Particulate and µg/l in dissolved) from the study stations

Stations	Summer		Autumn		Winter		Spring	
	Part.	Disso.	Part.	Disso.	Part.	Disso.	Part.	Disso.
1	1.428	1.605	1.625	1.527	1.821	1.784	1.626	1.522
2 before	2.357	2.119	1.949	2.124	2.924	2.358	2.236	2.363
2 after	1.625	0.747	2.032	0.946	0.929	0.95	0.845	1.745
3	1.411	1.038	1.427	1.126	1.527	1.285	1.154	1.429
4	2.984	3.133	1.364	2.647	4.032	3.371	3.232	3.022
5 before	1.259	1.187	1.387	1.126	1.426	1.39	1.297	1.343
5 after	2.364	1.215	1.299	1.102	1.526	1.39	1.256	1.386
6	1.112	2.038	1.212	2.111	2.682	2.222	2.121	2.485
7	1.127	0.047	1.125	1.003	1.145	1.038	1.026	1.123
8	1.355	1.069	1.162	1.023	1.324	1.15	1.113	1.255
Mean	1.702	1.419	1.458	1.473	1.933	1.693	1.590	1.767

Table (5): Seasonal variations in concentrations of (Pb µg/g in Particulate and µg/l in dissolved) from the study stations

Stations	Summer		Autumn		Winter		Spring	
	Part.	Disso.	Part.	Disso.	Part.	Disso.	Part.	Disso.
1	3.466	3.283	3.926	4.257	4.022	3.935	3.543	3.593
2 before	4.567	3.551	4.252	3.643	5.644	5.393	4.252	4.745
2 after	4.257	3.166	5.319	4.542	4.624	3.653	3.265	4.322
3	3.628	3.357	3.266	2.464	4.124	3.54	3.422	3.816
4	2.947	3.802	3.163	3.542	3.931	3.934	3.857	3.215
5 before	2.548	3.285	3.428	3.265	3.627	3.484	3.313	3.165
5 after	3.026	2.987	3.524	3.431	4.929	4.216	3.375	3.284
6	3.148	2.514	3.424	2.517	4.024	3.877	2.767	3.948
7	3.427	2.439	3.364	2.429	3.828	3.43	2.814	3.625
8	2.314	2.672	3.468	2.911	3.93	3.57	3.064	2.457
Mean	3.332	3.105	3.713	3.300	4.268	3.903	3.367	3.617

Table (6): Seasonal variations in concentrations of (Zn µg/g in particulate and µg/l in dissolved) from the study stations

Stations	Summer		Autumn		Winter		Spring	
	Part.	Disso.	Part.	Disso.	Part.	Disso.	Part.	Disso.
1	1.002	1.627	1.105	1.622	1.103	1.903	1.734	1.023
2 before	2.646	1.751	2.319	1.841	3.064	2.773	1.988	2.987
2 after	2.800	2.004	3.254	1.963	3.004	2.516	2.032	2.749
3	2.343	1.147	2.424	1.125	2.645	1.494	1.255	2.443
4	2.216	1.154	4.469	1.626	1.627	1.35	1.234	1.436
5 before	1.365	1.528	2.033	1.544	1.526	1.802	1.644	1.421
5 after	1.354	1.984	2.077	2.023	1.946	2.999	2.038	1.419
6	2.765	2.004	2.975	2.313	3.005	3.322	2.632	2.938
7	2.125	1.128	2.848	2.013	2.466	1.36	1.207	2.135
8	3.322	1.785	2.977	1.425	3.98	3.877	2.673	3.542
Mean	2.193	1.611	2.648	1.749	2.436	2.339	1.843	2.209

Table (7): Seasonal variations in concentrations of (Fe µg/g in particulate and µg/g in dissolved) from the study stations

Stations	Summer		Autumn		Winter		Spring	
	Part.	Disso.	Part.	Disso.	Part.	Disso.	Part.	Disso.
1	12.644	11.367	13.652	10.253	14.626	13.97	12.342	13.57
2 before	14.735	12.546	13.792	13.621	17.265	16.997	14.255	15.273
2 after	12.114	11.529	14.271	15.161	14.285	13.855	11.73	13.222
3	13.644	11.322	14.022	10.251	14.025	13.971	11.594	13.184
4	6.429	4.73	10.251	9.431	7.139	6.084	5.43	7.525
5 before	4.245	4.545	7.261	5.241	6.323	5.92	5.329	5.43
5 after	4.844	3.877	6.283	4.933	6.184	5.255	4.924	5.558
6	4.894	3.675	4.742	3.212	5.311	4.308	3.93	4.984
7	6.253	4.343	4.581	6.282	7.032	6.839	5.422	7.024
8	5.430	3.727	5.271	3.421	6.315	5.939	4.685	6.247
Mean	8.523	7.166	9.412	8.180	9.850	9.313	7.964	9.201

Whereas in the winter season, the highest value reached 16.997 µg/l in station 2 before feeding, while the lowest value was 4.308 µg/l in station 6 and mean 9.313 µg/l for all stations. In the spring season, the highest value reached 15.273 µg/l in station 2 before feeding; the lowest value was 4.984 µg/l in station 6 and mean 9.201 µg/l for all stations. the highest value of the dissolved phase occurred in the winter season in station 2 before feeding reached 16.997 µg/l. while the lowest value occurred in the autumn season in station 6 reached 3.212 µg/l. Decreasing of heavy elements in the dissolved phase in the present study may be due to the removal of these elements by their deposition on suspended materials, sedimentation and/or removal by the organisms, especially aquatic plants (Al-Atbee, 2018). (Morris, 1978) who noted that the heavy elements in the water are eventually separated into the suspended matter, sediments or living organisms. From the analyzes, the high concentrations of Fe and Pb are greater than other elements, this may be due to that Fe and Pb were found to have an anthropogenic origin and mainly came from industrial activities, through municipal sewage, domestic wastes, traffic source, and atmospheric deposition this finding was in agreement with ((Manoj *et al.*, 2012), Zn and Cu showed mixed origin from both anthropogenic and natural sources.

The concentrations of heavy elements in particulate matter mostly depend on many factors such as wastewater discharge, seasonal loads and the nature of basin (Al-Haidarey, 2009). Also, sewage and seepage from agricultural lands, the disposal of industrial and municipal effluent could change the concentrations of heavy elements in the particulate matters (Taobi *et al.*, 2000), the particulate, which contain organic matter, colloids and element hydroxide, have large surface area, therefore, they can adsorb great concentrations of heavy elements from aquatic environments.

Conclusions

1. Heavy elements, entering the aquatic environment, tend to be dispersed, so the methods used to monitor the elements in the aquatic environment, by determining their concentrations in water and Particulate.

2. According to waters analyzes, for four seasons, the concentration of the elements in the Particulate phase were as follow:
Fe > Pb > Zn > Ni > Cr > Cd > Cu

3. In the dissolved phase, the concentration of elements were found as follow :

Fe > Pb > Zn > Ni > Cr > Cu > Cd

4.The lake water is not suitable for drinking, due to the high concentrations of iron and lead during the different seasons, and this is due to the discharge of wastewater, agricultural drifts and rainwater.

5. The concentration of studied elements were higher in the Particulate phase as compared with the dissolved phase .

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بعض العناصر الثقيلة في الطورين الذائب والعالق في مياه هور الدلمج القادسية/محافظة الكوت

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المستخلص :

دراسة العناصر الثقيلة في الحالات الذائبة والعالقة للمياه بشكل فصلي للفترة من فبراير 2018 إلى نوفمبر 2018 في عشر محطات ، وتم اختيار هذه المحطات لتغطي جميع مساحة منطقة الهور ، ولمعرفة تراكيز تلك العناصر في الحالات المختلفة وباختلاف المواسم ، فضلاً عن تقييم مدى خطورتها على الصحة العامة في ضوء المعايير المسموح بها الخاصة بتلك الملوثات . وبينت النتائج المستخلصة من التحاليل ان تراكيز تلك العناصر متباينة فصلياً وبحسب المحطات المختارة ، وكانت النتائج كالآتي :

Cd:(Diss.0.123-0.182µg/l),(Par.0.129-0.195 µg/g),Cr:(Diss.1.207-1.429 µg/l), (Par.1.276-1.435 µg/g), Cu:(Diss.0.228- 0.571 µg/l), (Par. 0.237- 0.295 µg/g), Zn:(Diss.1.611-2.339 µg/l) , (Par.1.843-3.322 µg/g),Ni:(Diss.1.419-1.767 µg/l), (Par. 1.458-1.933 µg/g), Pb: (Diss. 3.105-3.903 µg/l), (Par. 3.332-4.268 µg/g), Fe:(Diss.7.166-9.313 µg/l), (Par.7.964-9.850 µg/g).

وبينت نتائج الدراسة انها ذات اهمية كونها تعطي معلومات اساسية لمنطقة الدراسة لمعرفة المناطق الاكثر تلوثاً بهذه الملوثات في منطقة الدراسة .

كلمات مفتاحية: معادن ثقيلة ، مياه، هور الدلمج ، العراق