Spatial and Monthly Variation in Co, Zn and Cd Concentrations of Surface Water of Shatt Al-Hilla River, Babylon, Iraq

SADIQ J. BAQR1, FALAH H. HUSSEIN1,* and FAIQ F. KARAM2

1Department of Chemistry, College of Science, Babylon University, Hilla 51002, Iraq
2Department of Chemistry, College of Science, Al-Qadisiya University, Al-Diwaniya 58002, Iraq

*Corresponding author: Tel: +964 7804009236; E-mail: abohasan_hilla@yahoo.com

INTRODUCTION

The contamination of water resources by heavy metals is a serious problem that can affect the environment since some of the heavy metals are very harmful1. Heavy metals are among the most persistent of contaminants in the ecosystem such as biota, sediments and water, because of their resistance to decompose in natural condition. Toxicity appears after increasing the level of indispensability. Heavy metals become toxic when they are not metabolized by the human body and accumulate in the soft tissues of this body2. Generally, in uninfected environment, most of the heavy metals are in very low levels and natural geological weathering of soil and rocks, directly exposed to surface waters, is usually the largest natural source. Main pollution with heavy metals by anthropogenic sources are mining, disposal of partially treated and untreated effluents contain toxic metals, as well as metal chelates from several industrial factories and indiscriminate use of fertilizer containing heavy metals. Heavy metals discharged into aquatic system by anthropogenic sources or natural during their transport are distributed between two phases: aqueous and sediments. Because of the following processes such as adsorption, hydrolysis and co-precipitation only a small portion of free metal ions stay dissolved in water while a large quantity of the metals deposited in the sediment. Although heavy metals are refractory though natural processes in the environment, they can be chemically changed by microorganisms and convert to organic complexes, some of which may be more hazardous to aquatic animals and human life3. Potentially toxic heavy metals, including zinc, cadmium and others, may participate in reactions and accumulate, causing deleterious effects in aquatic organisms4. The maximum allowed concentrations in drinking water of heavy metals are in the ppb range (e.g., 5 ppb for Cd and 110 ppb for Co)5. There are over 50 heavy metals that can be classified as heavy metals, only 17 of which are considered to be very toxic and relatively accessible1. The heavy metals in drinking water linked most often to human poisoning are copper, cadmium, zinc, etc. They are required by the body in small concentrations, but can also be toxic in large amounts. Cadmium is extremely toxic metal even in low amounts, it has a long biological half-life in the human body and the half-life of cadmium is range from 10 to 33 years. Long term exposures to this element also induce renal damage6.

Recently several techniques were used to determine heavy metals in environmental samples. These techniques include inductively coupled plasma mass spectrometry (ICP-MS)7-10; flame and graphite furnace atomic absorption spectrometry11-14; inductively coupled plasma optical emission spectrometry (ICP-OES)15-17; neutron activation analysis18; electrothermal vaporization inductively coupled plasma mass spectrometry (ETV-ICP-MS)19; inductively coupled plasma emission spectrometry (ICP-ES)20; flow injection solid phase extraction inductively coupled plasma mass spectrometry (FI-SPE-
ICPMS$^{27}$ and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS)$^{30}$. In Iraq and particularly in study area (Al-Hilla city), urban agriculture has been a normal practice along both river banks. The objective of this work is monitoring the rivers water over a long period of time in order to describe average metal pollution and its trend, which is essential component of any pollution control management.

### EXPERIMENTAL

**Description of study area:** Shatt Al-Hilla river is one of the main sources of water in the Babylon Governorate. This river starts from Saddat Al-Hindya and finishes on the southern borders of Al-Hilla city. Study area was described in previous work$^{39}$.  

**Sampling, collection of water samples and analytical methods:** Water samples have been collected from fourteen sites once monthly during the study period started in November 2011 and finished in October 2012. Sampling method was mentioned in previous work$^{39}$. The operating parameters of the atomic absorption analysis are given in Table-1.

### RESULTS AND DISCUSSION

The results of the determination are presented in Tables 2-4. These Tables show concentrations of Co$^{2+}$, Zn$^{2+}$ and Cd$^{2+}$ in water samples from various sampling locations during twelve months. Variation in the heavy metals concentration results due to the site position and the month of sampling which summarized as: The minimum value of cobalt concentration 0.012 ppm was recorded at sites 7, 8, 11 and 12 in October 2012 and the maximum value 5.4 ppm was recorded at site 3.

#### TABLE-2

| Site Number | Co (ppm) | Range (ppm) |
|-------------|----------|-------------|
| S1          | 1.600    | 0.080 - 1.700 | 0.080 - 1.700 |
| S2          | 0.800    | 0.120 - 0.750 | 0.100 - 0.100 |
| S3          | 0.100    | 0.120 - 0.500 | 0.100 - 0.100 |
| S4          | 1.000    | 0.160 - 1.000 | 0.100 - 0.100 |
| S5          | 2.000    | 0.120 - 2.000 | 0.100 - 0.100 |
| S6          | 2.800    | 0.160 - 2.600 | 0.100 - 0.100 |
| S7          | 2.000    | 0.200 - 1.700 | 0.100 - 0.100 |
| S8          | 1.000    | 0.080 - 0.500 | 0.100 - 0.100 |
| S9          | 1.600    | 0.080 - 1.400 | 0.100 - 0.100 |
| S10         | 2.000    | 0.120 - 3.000 | 0.100 - 0.100 |
| S11         | 2.400    | 0.160 - 1.900 | 0.100 - 0.100 |
| S12         | 1.800    | 0.120 - 3.600 | 0.100 - 0.200 |
| S13         | 0.400    | 0.080 - 2.600 | 0.100 - 0.100 |
| S14         | 3.000    | 0.080 - 4.400 | 1.000 - 0.100 |
| Mean        | 1.607    | 0.120 - 2.770 | 0.100 - 0.100 |

#### TABLE-3

| Site Number | Zinc (ppm) | Range (ppm) |
|-------------|------------|-------------|
| S1          | 2.000      | 0.060 - 0.730 | 0.107 - 0.145 |
| S2          | 1.700      | 0.220 - 0.660 | 0.134 - 0.074 |
| S3          | 0.030      | 0.140 - 0.730 | 0.056 - 0.200 |
| S4          | 1.710      | 0.190 - 0.670 | 0.024 - 0.250 |
| S5          | 1.480      | 0.260 - 0.030 | 0.024 - 0.260 |
| S6          | 1.210      | 0.110 - 1.250 | 0.032 - 0.260 |
| S7          | 1.890      | 0.080 - 1.440 | 0.032 - 0.100 |
| S8          | 1.700      | 0.039 - 0.670 | 0.024 - 0.100 |
| S9          | 1.950      | 0.070 - 0.760 | 0.032 - 0.100 |
| S10         | 2.730      | 0.100 - 1.000 | 0.040 - 0.100 |
| S11         | 2.070      | 0.050 - 0.020 | 0.040 - 0.210 |
| S12         | 1.360      | 0.060 - 0.610 | 0.046 - 0.120 |
| S13         | 1.870      | 0.098 - 0.440 | 0.064 - 0.200 |
| S14         | 1.270      | 0.058 - 0.780 | 0.032 - 0.070 |
| Mean        | 1.640      | 0.109 - 0.073 | 0.051 - 0.072 |

#### TABLE-1

| Metal | Wavelength (HCL) (nm) | Slit width (nm) | HCL current (mA) | Flame composition |
|-------|-----------------------|----------------|------------------|-------------------|
| Co    | 240.7                 | 0.2            | 6                | Air-acetylene flame |
| Zn    | 213.9                 | 0.2            | 5                | Air-acetylene flame |
| Cd    | 228.8                 | 0.2            | 3                | Air-acetylene flame |
in March 2012. The mean value of Co concentration in water for all sites shows a maximum value of 2.628 ppm in March 2012 and the minimum value of 0.066 ppm in October 2012. The results are shown in Table-2. The higher contents of cobalt in water is dangerous as it is carcinogenic and the low concentration of it causes vomiting, weakness, lack of concentration, hearing impairment, thyroid problems and cardio vascular disease. Cobalt enters the water from the effluents of industries dealing with corrosion and wear resistant alloys, colors, pigments and petroleum based industries. Previous studies indicate that the major sources of cobalt are domestic and industrial effluents. The maximum value of zinc concen-tration in water samples obtained was 1.98 ppm at site 13 in November 2011 and the minimum value was 0.01 ppm at site 3 in September 2012. The mean value of Zn concentration for all sites showed a minimum value of 0.027 ppm in October 2012 and the maximum of 1.641 ppm in November 2011. The results are presented in Table-3. The concentration of zinc observed is in the range permitted by the global regulations. Zinc is involved in various physiological and metabolic activities of many organisms but increase level of it can made many health disorder. The sources of Zn into the water bodies could be effluents of electroplateing, sewage effluents. The concentrations of zinc were in the range of WHO and EU.

The cadmium concentration is varied from 0.002 ppm as a minimum value recorded at site 4 in May 2012 to the maximum value of 1.55 ppm at site 12 in December 2011. The mean value of Cd concentration in water for all sites shown a maximum value of 1.372 ppm in December 2011 and the minimum value of 0.024 ppm in September 2012. The results are presented in Table-4. The higher concentration of cadmium than limits which is 0.033 ppm is very dangerous as cadmium is poisonous metal and can cause serious health problems and it has the tendency to accumulate in the body tissues that results in lung problems and kidney damage. Effluents from battery industries, dyes, pigments and alloy making are the major sources of cadmium in the water. The conductivity values (Table-6) for surface water ranged 822-1250 are within the safe limit of application.

The mean pH values in Table-5 for surface water ranged between 7.815 to 8.644, increasing in the range of pH value start from the upstream to downstream of the river which refer to increase the alkalinity in down direction of the river. The observed pH of the river water was well within the safe limit values for drinking and EU as well as for crop production. The
Conductivity values (Table 6) for surface water ranged 822-1250 are within the safe limit of application.

Conclusion

In conclusion, Co, Zn and Cd have shown elevated levels of heavy metals at many sites along Shatt Al-Hilla river in different seasons of the study. The increased levels of heavy metals in the water lead to accumulation of them in the agricultural soils and plants grown on the contaminated soils of heavy metals at many sites along Shatt Al-Hilla river in different seasons of the study. The increased levels of heavy metals resources which lead to addition of these metals into the river. Also, water should be tested systematically and regularly to keep monitoring process on the heavy metals pollutant into the water and purify the water, if necessary. Further, as the heavy metals enter the food chain and get accumulated at each levels from producers to consumers the heavy metal concentrations in soil and in various crops grown in the area is to be examined in addition to the river sediments which will affect the aquatic life in the river.

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