A study of Irrigation Water Pollution By Some Heavy Metals in Baghdad Governorate

Ali Akram Abdulateef¹ and Kadhim M. Naser²

¹ College of Environmental Sciences, Al-Qasim Green University, Iraq.
² College of Agricultural Engineering Sciences, University of Baghdad, Iraq.

Email: ali_akram87@environ.uoqasim.edu.iq
Email: Kadhim.n@coagri.uobaghdad.edu.iq

Abstract

A study of irrigation water was conducted in Baghdad city to find out extent of its pollution by some heavy metals (Pb, Cd, Ni, Co, Cu, Cr, Zn and Fe). Water samples were collected randomly from different sources (river, well, and stream). Results showed that the concentration of studied heavy metals were as follows: Lead between 0.43-11.75 mg L⁻¹, Cadmium between 0.01-0.95 mg L⁻¹, Nickel between 0.008-0.46 mg L⁻¹, Cobalt between Nil - 0.185 mg L⁻¹, Copper is between 0.326 - 1.58 mg L⁻¹, Chromium is between Nil-0.068 mg L⁻¹, Zinc 0.398-1.182 mg L⁻¹, as for Iron between 0.794 - 3.253 mg L⁻¹, and high concentrations of heavy metals were in all samples. The most sites were higher than a critical limits permitted by the International Food and Agriculture Organization.

Keywords: Water, Pollution, Heavy metals.

1. Introduction

Iraqi water pollution problem is one of the big problems that started to appear and increase, which necessitated serious thinking about finding ways to combat it and reduce its effects [1]. Water pollution is any physical, chemical or biological change in quality of water, directly or indirectly, that negatively affects living organisms or makes water unfit for drinking and required uses and is one of the main problems that most countries of world face due to the expansion of industrial activity. Water pollution greatly affects human life and living organisms, as many factories deliberately dispose of their waste and products of their industries such as oil derivatives, factory waste, city waste, chemical fertilizers, pesticides and disease-causing organisms, diseases and radioactive materials by throwing them into water, such as oceans, seas and rivers, so that water becomes less suitable for natural uses for drinking and agriculture. Heavy metals are present in very low concentrations not exceeding 50 µL⁻¹, when these waters are far from sources of pollution, but these concentrations may increase due to their proximity to sources of pollution [2], [3], explain in their study on assessing water pollution with heavy metals of Al-Quds power station in Baghdad, the presence of Lead, Nickel and Manganese contamination amounted to 29.6, 59.1 and 910 µgL⁻¹ and was higher than the permissible limits according to [4].

Heavy metals are considered dangerous environmental pollutants and their danger lies in their bio-cumulative characteristic in the bodies of living organisms that feed on plants cultivated in polluted soils for reasons related to factors of geological weathering of soil because of excessive use of chemical fertilizers and agricultural pesticides, most of the time it is the result of irrigation with water polluted with waste of factories, and sewage wastes [5]. The high traffic density of vehicles also plays an important role in increasing the concentrations of heavy metals in soils of inland road sites of Baghdad city due to the emissions of vehicles, and they took the following order in terms of the height of concentration: Zn > Ni > Pb > Cd [6]. [7] estimated concentrations of some heavy metals in water and sediments of Tigris River, explained the high concentration of lead in some of measured samples, and they attributed this to subtraction of large quantities of liquid waste towards river at south of city, and its concentrations in summer season are more than in the winter due to evaporation and sedimentation factor, as well as the discharge of industrial wastewater and others. [8] indicated that water of Diyala River was contaminated with lead and cadmium elements with high concentrations exceeding the permissible limits of [9] and poor water quality as its class C₁S₁ is low in Na and very high in salinity, and a significant increase of the Lead in shoot system at the flowering stage, plant was contaminated with Pb, as the concentrations reached 21.75 and 42.92 mg pb. kg⁻¹ dry matter successively. [10], on the effect of using Danvili Valley water in city of Mosul on contamination of soils with heavy metals showed that it is bad for agricultural purposes, depending on assessment of its physiochemical properties and concentration of heavy metals zinc, cadmium, lead, copper and iron, its mean concentrations in water samples were 7.07, 2.27, 8.87, 4.87, 6.70 mg L⁻¹.
2. Materials and Method

Water samples (of river, stream and well) were collected from twelve sites in city of Baghdad shown in figure 1 by 2.5 L plastic containers after washing them twice with water sample and adding drops of toluene to prevent bacterial growth. Chemical properties of water were estimated as shown in Table 1, concentration of dissolved heavy etals in water has also been estimated according to methods contained in [11] as follows: pH using a pH-meter type (HACH) model (HQ411d), electrical conductivity (EC) was measured using EC-meter type (HACH) model (EC71), dissolved ions of calcium and magnesium were determined by titration with fresnite, sodium and potassium was determined using a flame photometer model (AFP 100), chloride estimated by titration with 0.0141 standard silver nitrate, carbonate and bicarbonate assessed according to the methods in [12] Mediated titration with 0.01 N sulfuric acid, sodium adsorption ratio (SAR) values were calculated according to the formulas given in [13] as SAR = Na / √ (Ca + Mg)/2 mmolL⁻¹.

Water class was determined according to [14]. Heavy metals ions (Fe, Zn, Cr, Cu, Co, Ni, Cd, and Pb) were estimated in water samples after filtering the samples to get rid of impurities using Atomic Absorption Spectrophotometer (AAS) type Shimadzu model (AA7000).

3. Results and Discussion

3.1 Lead concentration

Figure 2. shows the concentration of Pb in water samples, The highest value of Lead concentration was in Diyala Bridge area, which was 11.57 mg L⁻¹ and the lowest value was in the Radwaniyah area 0.42 mg L⁻¹.
3.2 Cadmium concentration

Figure 3. shows the concentration of Cd in water samples. The highest value of Cd concentration was in Diyala Bridge area, which was 0.947 mg L\(^{-1}\), and the lowest value was in Salman Pak (Al Madaen), which was 0.01 mg L\(^{-1}\).

3.3 Nickel concentration

Figure 4. Ni concentration (mg L\(^{-1}\)) in water samples of study sites (Permissible limit for irrigation is 0.2 mg L\(^{-1}\)) [15].
Figure 4. indicates concentration of Ni in water samples, as the highest value of Ni concentration was in Diyala Bridge region, which was 0.457 mg L$^{-1}$, and the lowest value was in the Rasheed area, which amounted to 0.003 mg L$^{-1}$.

3.4 Cobalt concentration

Figure 5 indicates concentration of Co in water samples, as the highest value of Co concentration was in Diyala Bridge area, which was 0.185 mg L$^{-1}$, while lowest value was in Rashid and Yusufiya regions, whose value was imperceptible Nil mg L$^{-1}$.

Figure 5. Co concentration (mg L$^{-1}$) in water samples of study sites (Permissible limit for irrigation purposes 0.05 mg L$^{-1}$) [15].

3.5 Copper concentration

Figure 6 indicates the copper element Cu concentration in water samples, as the highest value of copper concentration was in Diyala Bridge area, which was 1.582 mg L$^{-1}$, while lowest value was in Abu Ghraib, 0.326 mg L$^{-1}$.
Figure 6. Cu concentration (mg L\textsuperscript{-1}) in water samples of study sites (Permissible limit for irrigation is 0.2 mg L\textsuperscript{-1}) [15].

3.6 Chromium concentration

Figure 7 indicates concentration of Cr in water samples, as highest value of Cr concentration was in Diyala Bridge region, which was 0.068 mg L\textsuperscript{-1}, while lowest value was in areas of Rasheed, Al-Dora, Abu Gharib, Al-Turath area, Karrada, and Al-Jadriya, whose value was imperceptible to Nil mg L\textsuperscript{-1}.

Figure 7. Cr concentration (mg L\textsuperscript{-1}) in water samples of study sites (Permissible limit for irrigation is 0.1 mg L\textsuperscript{-1}) [15].

3.7 Zinc concentration

Figure 8 shows concentration of Zn in water samples, as highest value of Zn concentration was in Diyala Bridge area, which was 1.182 mg L\textsuperscript{-1}, while lowest value was in Yusufiya area 0.398 mgL\textsuperscript{-1}.
3.8 Iron concentration

Figure 9 shows Fe concentration in water samples, as the highest value of Zn concentration was in Diyala Bridge area, which was 3.253 mg L\(^{-1}\), while lowest value was in Abu Ghrail area 0.794 mg L\(^{-1}\).

Figure 8. Zn concentration (mg L\(^{-1}\)) in water samples of study sites (Permissible limit for irrigation purposes 2.0 mg L\(^{-1}\)) [15].

Figure 9. Fe concentration (mg L\(^{-1}\)) in water samples of study sites (Permissible limit for irrigation purposes is 5 mg L\(^{-1}\)) [15].
As for concentration of Cr, Zn and Fe, all sites were found to be a threat to public health because of pollutants it contains, and increase in release of heavy metals. attributed this to density and population activity in area, frequent congestion of cars and burning of fuel, thus the river water is contaminated and Lead had highest concentration, followed by Ni, Cd, Co, Cr, Cu and Zn, they attributed to exacerbation of all kinds of pollutants inside Al-Rustumia station for heavy water purification, as a result of its poor treatment and contamination, including industrial and non-industrial pollutants. However, wastewater (sewage) resulting from filtering process is a major factor in pollution. As it poses a threat to public health because of pollutants it contains, and residents of neighboring areas may use this water for multiple purposes, including agriculture or drinking. [16], showed presence some heavy metals ions in water of Tigris River, as concentrations of Lead reached 0.01- 0.27mg L\(^{-1}\), Cd from imperceptible to 0.026 mg L\(^{-1}\), Ni ranged from imperceptible to 0.079 mg L\(^{-1}\), Co ranged from imperceptible to 0.096 mg L\(^{-1}\), Cu from imperceptible to 0.053 mg L\(^{-1}\), Cd from imperceptible to 0.757 mg L\(^{-1}\), and Zn from imperceptible to 0.942 mg L\(^{-1}\), thus the river water is contaminated and Lead had highest concentration, followed by Ni, Cd, Co, Cr, Cu and Zn, they attributed this to density and population activity in area, frequent congestion of cars and burning of fuel, which leads to an increase in release of heavy metals.

### Table 1. Some chemical properties of water samples.

| No. | Water samples      | pH   | EC  | Na\(^+\) | K\(^+\) | Mg\(^{2+}\) | Ca\(^{2+}\) | Cl  | HCO\(_3\^-\) | CO\(_3^{2-}\) | SO\(_4^{2-}\) | SAR | Water class |
|-----|--------------------|------|-----|----------|---------|------------|-----------|-----|-------------|-------------|--------------|-----|-------------|
| 1.  | Radwaniyah (Stream)| 7.95 | 1.25| 0.95     | 0.01    | 2.44       | 3.42      | 7.42| 0.37        | Nil         | 2.05        | 0.39| C3S1        |
| 2.  | Mahmoudiya (well)  | 8.18 | 4.38| 2.29     | 0.11    | 8.36       | 10.75     | 26.08| 0.26        | Nil         | 8.05        | 0.52| C4S1        |
| 3.  | Adhamiya (River)   | 7.95 | 0.97| 0.38     | 0.12    | 2.06       | 2.31      | 5.98| 0.25        | Nil         | 1.41        | 0.18| C3S1        |
| 4.  | Rasheed (Stream)   | 7.98 | 1.90| 0.86     | 0.14    | 3.47       | 5.02      | 4.11| 0.41        | Nil         | 4.85        | 0.30| C3S1        |
| 5.  | Dora (well)        | 9.73 | 3.52| 7.52     | 0.13    | 5.71       | 8.92      | 18.22| 1.05        | Nil         | 7.91        | 1.97| C4S1        |
| 6.  | Abu Ghraib (well)  | 7.94 | 2.35| 1.65     | 0.17    | 4.98       | 4.84      | 14.14| 0.57        | Nil         | 4.15        | 0.53| C4S1        |
| 7.  | Youssoufia (river) | 7.91 | 1.01| 1.09     | 0.11    | 1.32       | 2.17      | 8.37| 0.72        | Nil         | 0.65        | 0.58| C3S1        |
| 8.  | Salman Pak (Stream)| 7.7  | 1.74| 4.28     | 0.11    | 2.83       | 2.50      | 9.23| 0.63        | Nil         | 2.85        | 1.85| C3S1        |
| 9.  | Rashidiya (Stream) | 7.6  | 1.92| 8.43     | 0.13    | 2.00       | 2.60      | 12.48| 0.79        | Nil         | 2.51        | 3.93| C3S1        |
| 10. | District Area (well)| 8.01| 2.95| 9.09     | 0.15    | 3.42       | 5.88      | 20.35| 1.45        | Nil         | 2.80        | 2.98| C4S1        |
| 11. | Karrada and Jadiro (river) | 7.68| 1.38| 1.17     | 0.18    | 2.17       | 2.55      | 7.22| 0.54        | Nil         | 2.05        | 0.54| C3S1C3S1    |
| 12. | Diyala Bridge (river) | 7.74| 1.41| 2.01     | 0.17    | 2.46       | 2.81      | 8.53| 0.60        | Nil         | 3.14        | 0.88| C3S1        |

Results showed that lead concentration exceeded permissible limit according to classification of FAO (1994), which is 5 mg L\(^{-1}\) in Diyala Bridge area, while rest of sites were within the permissible limit. As for Cadmium concentration, it exceeded permissible limits in all water samples for study sites, which amount to 0.01 mg L\(^{-1}\), concentration of Ni and Co exceeded permissible limit (0.2 and 0.05 mg liter \(^{-1}\), respectively) in Diyala Bridge area, while rest of sites were within the permissible limit, Cu concentration exceeded permissible limit in all study sites. As for concentration of Cr, Zn and Fe, all sites were within permissible limit (0.1, 2.0, 5.0 mg L\(^{-1}\), respectively). Water pollution in general and Diyala River in particular, may be attributed to exacerbation of all kinds of pollutants inside Al-Rustumia station for heavy water purification, as a result of its poor treatment and contamination, including industrial and non-industrial pollutants. However, wastewater (sewage) resulting from filtering process is a major factor in pollution. As it poses a threat to public health because of pollutants it contains, and residents of neighboring areas may use this water for multiple purposes, including agriculture or drinking. [16], showed presence some heavy metals ions in water of Tigris River, as concentrations of Lead reached 0.01- 0.27mg L\(^{-1}\), Cd from imperceptible to 0.026 mg L\(^{-1}\), Ni ranged from imperceptible to 0.079 mg L\(^{-1}\), Co ranged from imperceptible to 0.096 mg L\(^{-1}\), Cu from imperceptible to 0.053 mg L\(^{-1}\), Cd from imperceptible to 0.757 mg L\(^{-1}\)and Zn from imperceptible to 0.942 mg L\(^{-1}\), thus the river water is contaminated and Lead had highest concentration, followed by Ni, Cd, Co, Cr, Cu and Zn, they attributed this to density and population activity in area, frequent congestion of cars and burning of fuel, which leads to an increase in release of heavy metals.

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