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Pollution Evaluation of Irrigation Water in Paddy Fields at Al-Mishkhab Area, Iraq

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Abstract: ***Al-Mishkhab area in Al-Najaf governorate is the largest and the firstin rice production in Iraq, rice comes at the forefront of major food. To investigate the heavy metals contents of irrigation water and classify the irrigation water quality of paddy fields using pollution indices ten irrigation water samples were collected and analyzed for heavy metals by Atomic Absorption Spectrometer (AAS). The results showed that all tested heavy metals contents of irrigation water in paddy fields were less than local and worldwide limits. OverallHPIforsamples within study area are found to be far above the critical level of 100 which reveals that the water is polluted with respect to heavy metals, thatmay beattributedtoagriculturaleffluents of the area. The MI value is also far above the threshold of warning with respect to heavy metals suggeststhatthe irrigation water samples are moderately affected.***

Keywords: paddy fields, irrigation water, Heavymetal pollution index, Metal pollution Index

1. Introduction

Water plays fundamental functions in processes both geochemical and biochemical. It is also a main carrier for all chemical elements; its amount and chemical composition control element cycling in water-air-soil systems. Water pollution by heavy metals is an important factor in both geochemical cycling of heavy metals and in environmental health. The hydro cycle of heavy metals plays a significant role in each aquatic and terrestrial ecosystem. Ecological consequences of trace element pollution of waters are difficult to predict and to assess. Most heavy metals, especially trace metals, do not remain in soluble forms in waters, for a longer period. They are present mainly as suspended colloids or are fixed by organic and mineral substances (Kabata-Pendias and Mukherjee, 2007).

The study area is located in the agricultural lands of Al-Mishkhab area south west Iraq between latitudes (31° 52′ 20″N) to the north and longitude (44° 29° 37″E) to the east (Figure 1). Geologically, the study area is located within the Salman Subzone which belongs to the Stable Shelf Zone, Covered by Quaternary deposits. The Quaternary era is characterizedby the development of the river systems and by the modeling of the country's relief by simultaneous erosion (Jassim and Goff, 2006). The objectives of this study are to investigate the heavy metals contents of irrigation water and classify the irrigation water quality of paddy fields using pollution indices.

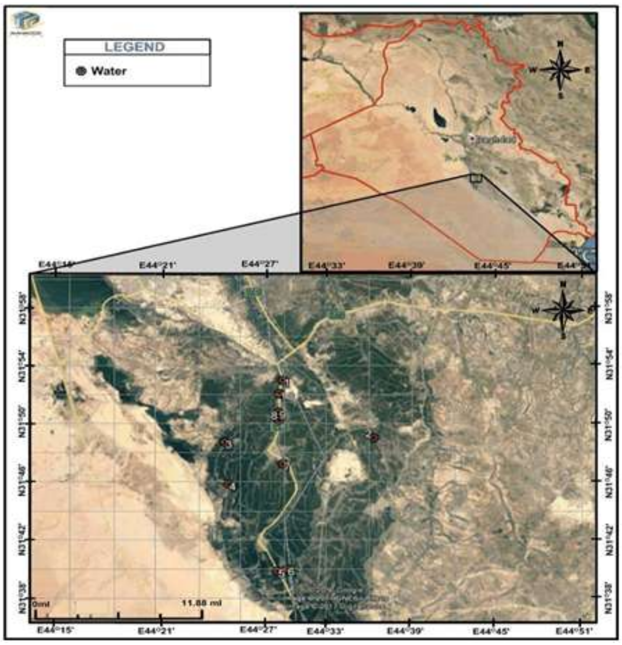

Figure 1: Location map of water samples

2. Materials and Methods

Ten irrigation water samples were collected from the nearby irrigation water from selected paddy fields (Figure 1). Heavy metal analyses have been conducted in the Ministry of Science and Technology, by Atomic Absorption Spectrometer (AAS).

Heavy metal Pollution index

Heavy metal pollution index(HPI) is a technique of rating thatprovidesthecomposite influenceof individualheavy metal on theoverall qualityofwater.Theratingisavaluebetweenzero and one, reflecting therelative importanceof individual quality considerations and inversely proportional to the recommended standard (Si) for eachparameter (Reza, Singh, 2010; Prasad and Mondal, 2008 Prasad, Kumari, 2008). The calculationofHPI asfollows:

$$W_i = k/S_i \qquad \text{................ (1)}$$

Where W_i is the unit weightage and S_i the recommended standard for i^{th} parameter, while k is the constant of proportionality. Individual quality rating is given by the expression

$$Q_{i=} \quad 100V_i/S_i \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Where Q_i is the subindex of i^{th} parameter, V_i is the monitored value of the i^{th} parameter in mg/land S_i the standard or permissible limit for the i^{th} parameter.

The Heavy Metal Index (HPI) is then calculated as follows

$$\text{HPI}=\sum_{i\,1}(\mathbf{Qi\ Wi})/\sum_{I\,1}\mathbf{Wi} \ldots\ldots\ldots\ldots\ldots (3)$$

Where Q_i is the subindex of i^{th} parameter. W_i is the unit weightage for i^{th} parameter, n is the number of parameters considered.

The critical pollution index value is100.

For the present study the S_i value was taken from the Iraqi drinking water specifications standard, 2009,No.417.

Metal pollution Index

Another index used is the general metal index (MI) for drinking water (Bakan et al., 2010) which takes into account possible additive effect of heavy metals on the human health that help to quickly evaluate the overall quality of drinking waters. Metal pollution Index is given by the expression proposed by (Caeiro et al., 2005).

$$\text{MI}=\sum[\text{Ci}/(\text{MAC})\text{i}]$$

Where MAC is maximum allowable concentration and Ciismean concentration of each metal. The higher the concentration of a metal compared to its respective MAC value the worse the quality of water. MI value>1 is a threshold of warning (Bakanet al., 2010). Water quality and its suitability for drinking purpose can be examined by determining its metal pollution index (Mohan et al.,1996; Prasad & Kumari, 2008).

3. Results and Discussion

Table 1 illustrates the concentration of heavy metals of irrigation water for paddy fields.

Cadmium may enter into water systems from various sources of which smelting of nonferrous metal ores are considered to be the largest one (Kabata-Pendias and Mukherjee,2007). The use of phosphate fertilizers, land application of municipal sewage sludge and mining and smelting activities, Cd concentration in irrigation water of the study area ranges from 0.003 to 0.005 mg/l with mean 0.0044 mg/l these concentrations were less than local and worldwide limits (Table1).**Cobalt** mining operations that processed cobalt containing ores may continue to release cobalt into surface water and groundwater. Waste water from the recovery of cobalt from imported matte or scrap metal and during the manufacture of cobalt chemicals are sources of cobalt in water (Smith and Carson 1981). Co concentration range in irrigation water of the study area ranges from 0.008 to 0.02mg/l with mean 0.01257mg/l(Table1). **Chromium** during erosion and transport is relatively low, the main chromium mineral is chromites, and chromium compounds can be found in river waters only in trace amounts and industrial wastewaters can be caused pollution in river water (Gaillardet et al. 2003). Chromium concentration in irrigation water of the study area ranges from 0.005 to 0.001mg/l with mean 0.007mg/l is less than local and worldwide limits (Table1). **Copper** can enter the river water through releases from factories that make or use copper metal or copper compounds, waste dumps, domestic waste water, combustion of fossil fuels and wastes, wood production, phosphate fertilizer production, and natural sources (ASTDR, 2005). Cu concentration in irrigation water of the study area ranges from 0.003 to 0.01mg/l with mean 0.0065mg/l is less than local and worldwide limits. **Lead**Worldwide reports confirm that there are great variations in **Pb**concentrations in water. The Pb concentrations in surface waters depend especially on the pH and dissolved salt contents of the water. Additional factors, such as pollution sources, sediment Pb content, temperature, and organic matter kinds and amounts have also significant impact on the Pb status in waters (Kabata-Pendias and Mukherjee, 2007). Lead concentration in irrigation water of the study area ranges from 0.001 to 0.003mg/l with mean 0.0019mg/l is less than local and worldwide limits (Table1). **Manganese** is relatively easily mobile in the terrestrial environment (Gaillardet et al. 2003). Mn concentration in irrigation water of the study area ranges from 0.007 to 0.008mg/l with mean 0.007667mg/l is less than local and worldwide.**Nickel**concentrations in river waters range from 0.15 to 10.39 mg/l, and the world average is 0.8 mg/l (Gaillardet et al. 2003). Ni concentration in irrigation water of the study area ranges from 0.003 to 0.02mg/l with mean 0.006625mg/l is less than local and worldwide limits. World average of **Zinc** in river waters has been calculated at 0.6 mg/l (Gaillardet et al. 2003). Zn concentration in irrigation water of the study area ranges from 0.01 to 0.02mg/l with mean 0.01125mg/l is less than local and worldwide limits (Table 1). All heavy metals in study area less than local and worldwide limits.

Table 1: Concentrations of heavy metals of irrigation water and comparing with local and worldwide (mg/l).

Heavy metals	Range	Mean	IQS, 2009	WHO, 2011	EPA, 2011
Cd	0.003- 0.005	0.0044	0.003	0.003	0.005
Co	0.008-0.02	0.012571	---	--	--
Cr	0.005-001	0.007	0.05	0.05	0.1
Cu	0.003-0.01	0.0065	1	2	1.3
Fe	0.01-0.02	0.0135	--	--	---
Pb	0.001-0.003	0.0019	0.01	0.01	0.015
Mn	0.007-0.008	0.007667	0.1	0.4	---
Ni	0.003-0.02	0.006625	0.02	0.07	---
Zn	0.01-0.02	0.01125	3	3	5

Table 2: Mean HPI of the irrigation water samples.

Heavy metal	mean mg/l Vi	Highest permitted value mg/l (Si)	Unit weightage (Wi)	Subindex Qi Si	Wi x Qi	HPI
Cd	0.0044	0.003	333.333	146.6667	48888.8889	102.59
Cr	0.007	0.05	20	14	280	
Cu	0.0065	1	1	0.65	0.65	
Pb	0.0019	0.01	100	19	1900	
Mn	0.007667	0.1	10	7.667	76.67	
Ni	0.006625	0.02	50	33.125	1656.25	
Zn	0.01125	3	0.33333333	0.375	0.125	
			∑ Wi=514.66		∑ Wi x Qi=52802.58	

Table 3: Mean MI of the irrigation water samples.

Heavy metal	Mean mg/l Ci	Highest permitted value mg/l ((MAC)i)	MI	∑ MI
Cd	0.0044	0.003	1.4666	2.2148
Cr	0.007	0.05	0.14	
Cu	0.0065	1	0.0065	
Pb	0.0019	0.01	0.19	
Mn	0.007667	0.1	0.07667	
Ni	0.006625	0.02	0.33125	
Zn	0.01125	3	0.00375	

In order to calculate the HPI of the water, the mean concentration value of the selected metals (Cd, Cr, Cu, Pb, Mn, Ni and Zn) have been taken into account table(2). The values of Heavy Metal Pollution Index (HPI) was found to be in the range of 102.59. Overall HPI for samples within study area are found to be far above the critical level of 100 which reveals that the water is polluted with respect to heavy metals due that may be attributed to agricultural effluents of the area. The MI value is also far above the threshold of warning with respect to heavy metals suggeststhatthe irrigation water samples are Moderately affected, table (3)

Table 4: Water Quality Classification using MI (Lyulko et al., 2001; Caerio et al., 2005).

MI	Characteristics	Class
<0.3	Verypure	I
0.3-1.0	Pure	II
1.0-2.0	Slightlyaffected	III
2.0-4.0	Moderatelyaffected	IV
4.0-6.0	Stronglyaffected	V
>6.0	Seriouslyaffected	VI

4. Conclusion

The investigation of heavy metals contents of irrigation water in paddy fields were less than local and worldwide limits.OverallHPIforsamples within study area are found to be far above the critical level of 100 which reveals that the water is polluted with respect to heavy metals, thatmay beattributedtoagriculturaleffluents of the area.The MI value is also far above the threshold of warning with respect to heavy metals suggeststhatthe irrigation water samples are moderately affected.

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