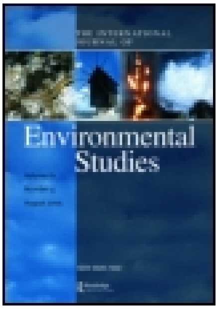

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ON THE SPATIAL AND SEASONAL VARIATIONS OF HEAVY METALS OF THE RAZZAZAH LAKE, IRAQ

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Five heavy metals, namely Cd, Cu, Fe, Mn, and Pb in the surface water and through the water column were studied at 10 selected stations in the Razzazah lake and Karbala drainage canal for the period between November 1990 to October 1991*. pH and total hardness were also measured. Lead was found to be the highest in concentration as overall average values, followed by an manganese, iron, copper then cadmium at the surface as well as along the water column. All the studied metals were below or close to the maximum allowed limits of Iraqi standards for inland water. The spatial and seasonal variations were discussed.

KEYWORDS: Razzazah lake, heavy metals, seasonal variations.

INTRODUCTION

Several heavy metals are essential for metabolism but may become toxic at certain concentrations. There are always traces of metal ions in water, particulate and sediments from riverine areas, but the background levels are poorly documented in literature[1]. Trace metals in aqueous solution are seldom free ions, but exist as ionic complexes utilizing a variety of organic, inorganic and hydrated ligands which affect mobility, reactivity and solubility[2].

The normal metal content in aquatic environment has not been clearly defined, since it varies from one place to another according to geological nature of the catchment area. Such data are essential to impact of pollution sources, and for the study of transfer to man by various means[3]. The healthy stream or lake has a balance of plant and animal life represented by a great species diversity. Pollution disrupts this balance, resulting in a reduction in the variety of individuals and dominance of the surviving organisms[4].

No study has been undertaken, however, addressing the distribution of heavy metals in the Iraqi inland lentic water, whereas some work already appeared on lotic water[5–7].

The aim of the present study is to provide the status and distribution of several heavy metals in Razzazah lake, as a response to water quality control since the lake has been lately considered for fishery development.

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* This study was confined to a one year period beceause of difficulty to reaching the area after 1991 (editor)

STUDY AREA

The Razzazah lake was established in 1943 having a water capacity of 26 x 10^9 m^3 in an arid area with an annual rainfall less than 125 mm and evaporation more than 1.25 m per year. It is a shallow one with maximum depth of 17 m and area ranges between 1050 – 1700 Km^2 (Figure 1). It is considered a closed lake with no outlet, and receives water mainly from the Habbaniya lake at northern part, through the Al-Majara canal, which is now closed and from the Karbala drainage canal at the south-east part at a current velocity of 5 m sec^{-1}. There are also, several small inlets present on West part. The surrounded area is characterized by clay-sandy soil with several layers of sediment rocks, gypsum and calcareous in nature.

MATERIALS AND METHODS

Nine stations were selected in the lake 1,2 and 3 represented the north part, 4.5 and 6 the west, 7 and 8 the south and 9 the east. Station 10 was taken in the Karbala drainage canal (Figure 1). Monthly surface water (30 cm) samples were taken from each station for the period from November 1990 to October 1991. Two stations (3 and 9) were chosen to study the water column at different depths (3 and 6 or 9 m) using a Vandorn sampler.

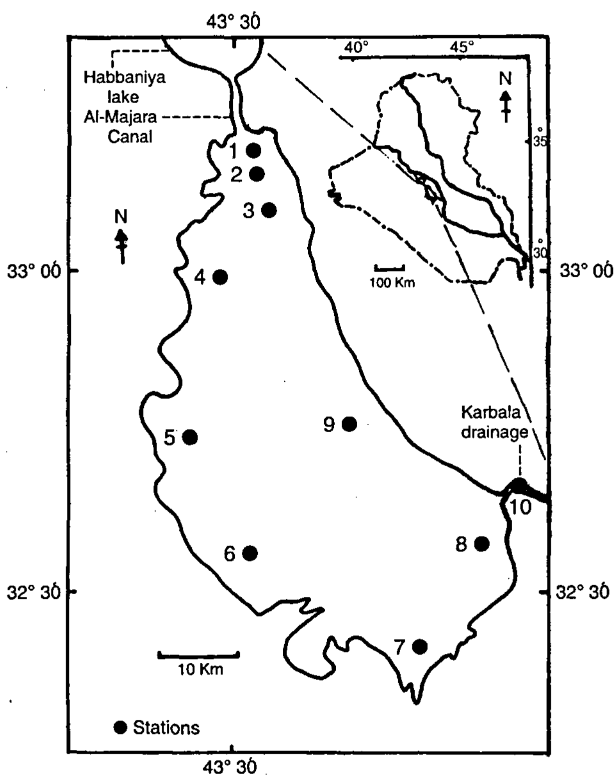

FIGURE 1 Map of the Razzazah lake showing the position of stations.

A portable pH meter (Model pH 90) was used to determine the pH values. Total hardness was estimated following the method cited by Lind[8]. Five heavy metals (Cd, Cu, Fe, Mn and Pb) were determined from water samples after filteration, using a Pye-Unicam flameless atomic absorption spectrophotometer, model SP9[9].

RESULTS AND DISCUSSION

The water chemical characters, mainly pH and hardness, play an important role in the concentrations of heavy metals of a given ecosystem. The ranges of pH and hardness values in the present study were 7.4–8.7 and 3142–7216 mg $CaCO_3l^{-1}$ in the lake, but 7.4–8.5 and 2211–3433 mg $CaCO_3l^{-1}$ in the drainage canal, respectively. The water of the studied area considered very hard[10]. There were no pronounced horizontal and vertical variations among the studied stations in total hardness and pH, which clearly indicated a good buffer system in the lake. The heavy metal concentrations increased by lowering pH values for a certain range. This conclusion does not apply to the present study[11].

As the average values concerned. Pb was found to be the highest among the studied metals in the lake, followed by Mn, Fe, Cu and Cd at the surface and along the water column (Figures 2 and 3). A similar sequence was also found in the drainage canal

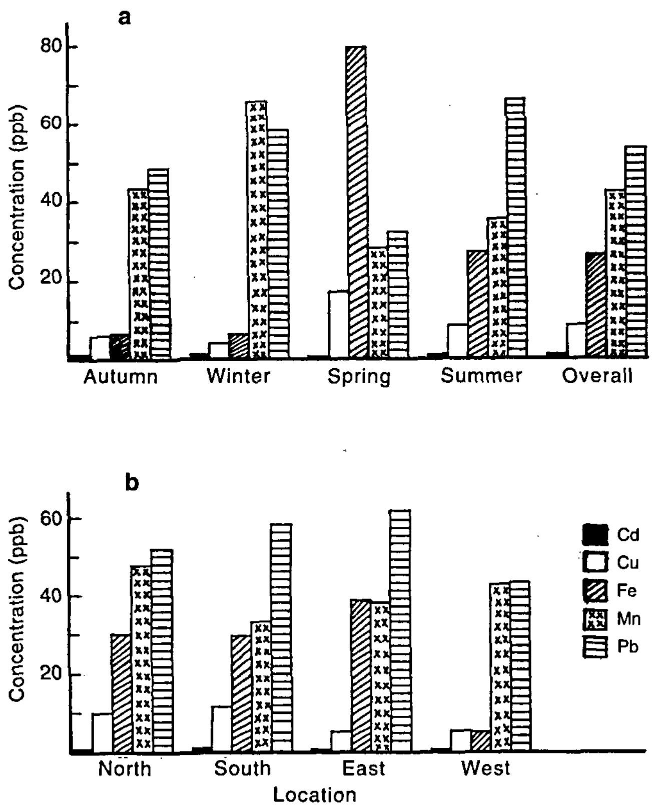

FIGURE 2 The concentrations of the studied heavy metals in the Razzazah lake at surface water on a seasonal (a) and locality (b) basis.

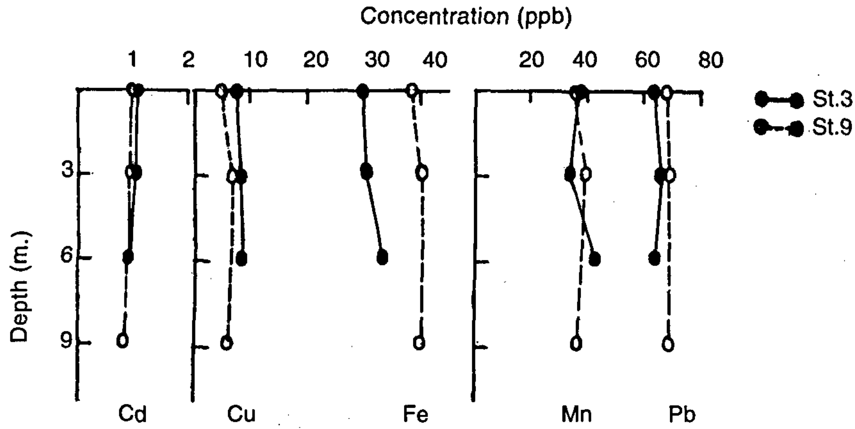

FIGURE 3 The concentrations of the studied heavy metals in the Razzazah lake along the water column at two studied stations.

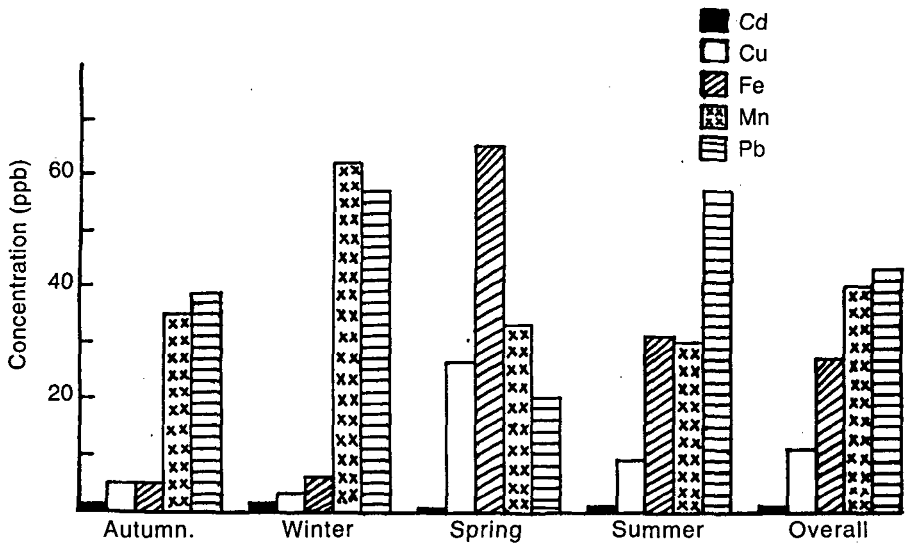

FIGURE 4 The concentrations of the studied heavy metals in the Karbala drainage canal on a seasonal basis.

(Figure 4). A different sequence was found in the Shatt al-Arab estuary[5,6,12]. They found no significant spatial variations in the studied trace metal concentrations; this was attributed to the huge flushing volume of the estuary.

The values of the studied metals in the present investigation were higher than those recorded in the Samarra impoundment on the Tigris river[13]. Also, the values of Cu, Fe and Pb determined in the drainage canal were higher than those recorded in the Saklawia drainage canal near Baghdad[14].

In comparison, Pb. Mn and Cd had slightly higher values in the lake than in the canal, *vice versa* in the case of Fe and Cu values. Nevertheless, except for Pb, all values recorded in the present study were lower than the maximum allowed limits of the Iraqi standards for inland water[15]. Pb was more or less close to these limits. No previous studies were published on Iraqi lentic ecosystems to enable us to compare the present results.

On the average Cd was also the lowest among the studied metals in the lakes of southern Norway[16]. They recorded similar values of Cd and Cu with those of our study, whereas lower values of Pb were recorded. These variations may be attributed to different atmospheric deposition due to different localities. Longrange atmospheric transport of pollutants affects the chemistry of heavy metals in natural water in several ways.

The overall values of the studied heavy metals indicated small spatial variations which were the highest in the east then north, south and east part of the lake. These variations may be due to a different geological nature of the catchment area, as well as the different anthropogenic inputs, such as agricultural and industrial wastes.

1. *Cadmium*

The unpolluted water usually contains less than 1 ppb of Cd, but sometimes may reach more than 10 ppb in natural as well as drinking water. According to Iraqi standards for natural water, it should not be more than 5 ppb[15], whereas according to WHO[17] it is not more than 10 ppb. In our study, its value ranged between 0.12–2.47 ppb with no pronounced vertical and horizontal variations. On a seasonal basis, the lowest concentration was found in the Spring. Similar values were obtained in Tigris river near Baghdad[18].

It is known that a negative correlation exists between this metal concentration and hardness. The hard water allows the metal to precipitate, and *vice versa* in soft water which has enough acidity to dissolve it. The very hard and alkaline water of the studied area contributed to the present low values of the metal.

2. *Copper*

The Cu values in the lake ranged between U.D. to 36 ppb (average ca 8 ppb). The highest average value was recorded in the Spring (17 ppb) and the lowest (4 ppb) in the Winter. Although no pronounced variations were found horizontally and vertically in the lake, it appears that lightly higher values were found in the southern part. Higher values were also recorded in the drainage canal (average 11 ppb), which may be due to the strong current. These ions have high adsorption forces at the soil particle surfaces. The rise of pH values increases these forces at the solid surface along with the formation of ion complexes in the solutions and the total concentration of the free ions in solution remains nearly stable[11].

The maximum allowed Cu concentration in Iraqi standards for inland natural water is 100 ppb[15]. In our study, its concentration was below the allowed values in both the lake and the canal.

3. *Iron*

Fe is one of the essential nutrients for phytoplankton growth. It plays with Mn, clay and organic matter a role in the other metal concentrations in the sediments[4].

The average values of Fe in the lake (26 ppb) and the drainage canal (27 ppb) were similar and lower than those recommended by the Iraqi authority in natural inland water and by WHO[15,17].

There were few spatial and seasonal variations in Fe values in the lake as well as at in the canal. The highest value was found in the eastern part (average 39 ppb), and the lowest (5 ppb) in the west, whereas similar average values (ca 30 ppb) were found in both the southern and northern parts. On a seasonal basis, the highest values were recorded during the Spring, and the lowest during the Autumn and Winter. This may be due to a different uptake and activity of the living aquatic organisms.

4. *Manganese*

The range of the recorded Mn values were 31–88 ppb and 18–62 ppb, and as average of 42 ppb and 40 ppb in the lake and the drainage canal, respectively. These values are lower than the permissible concentrations (10 ppb) in the natural inland water by Iraqi authorities[15]. WHO[17] indicated that the recommended and the highest allowed concentrations were 50 and 500 ppb, respectively.

Soil may consider the main source of Mn distribution, and the particles of this metal tend to sink to the bottom since they are sediments in origin[4]. Such phenomena may apply in the studied area and explain why there were no pronounced variations between the lake and the canal indicated above.

5. *Lead*

Pb values were in the range 20–206 ppb (average 53 ppb), and 13–97 (average 43 ppb) in the lake and the drainage canal respectively. These values were close to the recommended concentrations[15,17], 50 and 100 ppb, respectively. The high values of Pb may be due to its high dissolving ability. Pb, values were much higher than Cu values & inceased more than tenfold during the Winter in the present study; this may be due to the fact that Pb solubility is much higher than that Cu in solutions of pH (6–8,3)[19]. Although, Pb is among the most common polluting metals in the environment, it is found at low concentrations in water (1–100 ppb at the surface water), due to a rapid adsorption ability on sediment particles as well as organic complexes formation[20].

On a seasonal and spatial basis, no pronounced variations were recorded. The lake showed slightly higher values than the drainage canal in all seasons.

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