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Concentrations of Trace Metals in Aquatic Plants and sediments of the Southern Marshes of Iraq (Al-Hawizah and Al-Hammar)

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Absract

The analysis of trace metals Cd, Pb, Cu, Zn, Mn and Fe in six species of aquatic plant species and sediments of Al-Hawizah and Al-Hammar marshes were investigated . It was found that the nature of the region is unpolluted with the trace metals. The ability of these plants to accumulate and eliminate trace metals in relation to their concentrations in ambient led to the observed variations in metal concentrations in plants. The results showed higher concentration of trace metals in sediment than in plants. No significant difference were observed in trace metals concentrations in aquatic plants and sediment samples for both Al-Hawizah and Al-Hammar marshes .Generally , the levels of the studied metals in plants and sediments of region were lower than the other compared areas of the world.

1-Introduction

For effective water pollution control and management there is a need for a clear understanding of the inputs (loads), distribution and fate of contaminants, including trace metals from land-based sources into aquatic ecosystems. In particular, the quantities and qualities need to be considered together with the distribution pathways fate and the effects on biota. Trace metals enter the aquatic environment from both anthropogenic and natural sources (Zoller, 1984).

In the aquatic environment, metals are partitioned among the various aquatic environmental compartments (water, suspended solids, sediments and biota). The metals in the aquatic environment may occur in dissolved, particulate and complexed form (Biney1991).

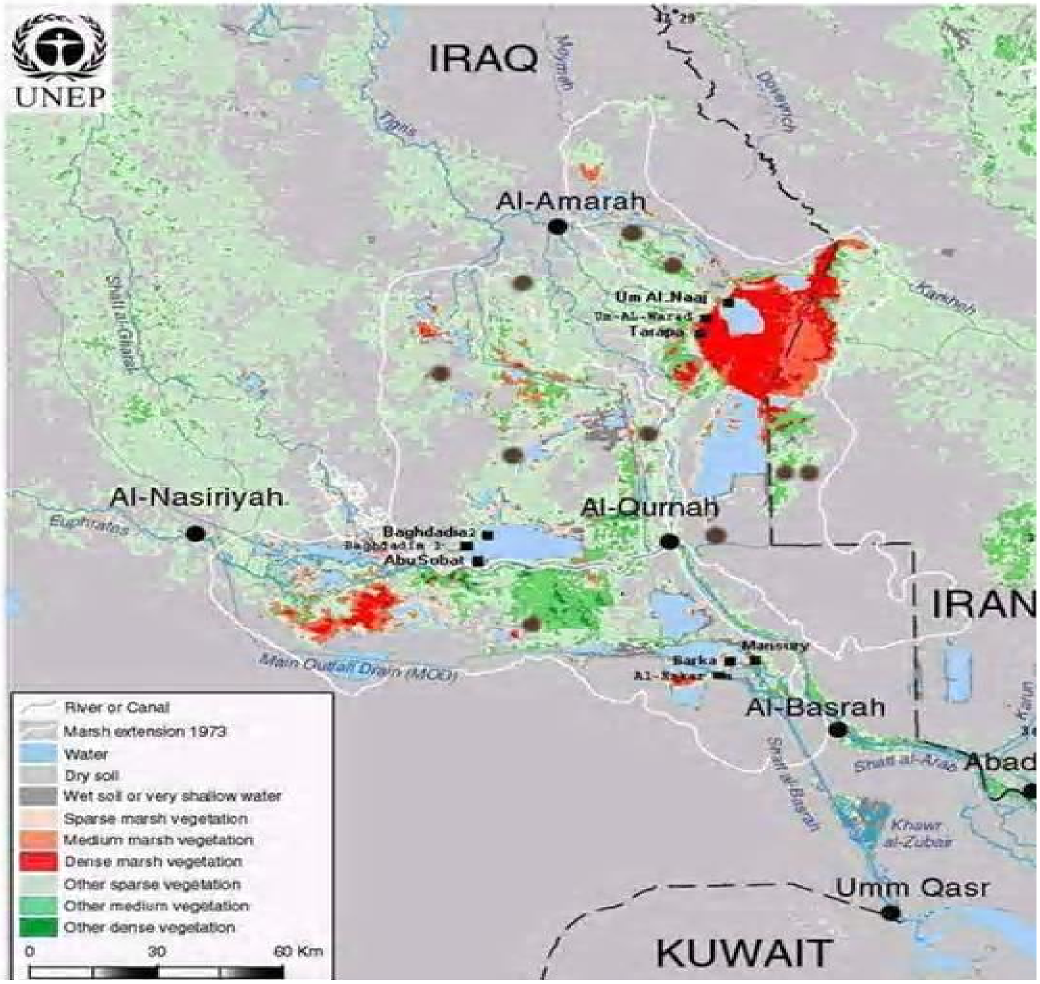
Metal contamination of the aquatic environment may lead to deleterious effects from localized inputs which may be acutely or chronically toxic to aquatic life within the affected area. Most published data on the effects of metals on aquatic organisms, reported adverse effects at concentrations higher than usually found in the environment (GESAMP, 1988).

Despite the different matrices, sediments have been more analyzed because they can present a clearer indication of metal inputs and accumulation in aquatic environments (Thomas 1972) . Although the plant are considered an essential part of the food web in the region (Al-Saadi and al-Mousawi 1988), little is known on the plant ecology of the marshes in Iraq (Al-Hilli 1977) and only slightly more on the Limnological parameters (Antoine 1984). The development of the industry and expansion of the chemical compounds used in different branches of industry are leading to the environmental spread of heavy metals and the increasing pollution with many heavy metals in the Southern mershes of Iraq has been the subject of considerable interest (Al-Saad and Mustafa 1994, Mustafa etal 1995, Al-Saad etal 1994,2007, Bedair *etal* 2006).

In this work the concentrations of Pb , Cd , Zn, Cu, Mn and Fe were determined in sediment samples and the following plants species from the Al-Hawizah and Al-Hammar marshes: *P. Crispus, P. nodosus, Ceratophyllum demersum, Salvinia. natans, Potamogeton pectinatans, Salicornia herbaceal* and *Vallisneria spiralis* .

2-Materials and Methods

Plants were collected from Al-Hawizah and Al-Hammar marshes during 2005-2006 (Fig.1) .The samples were freez-dried and grounded with agate mortar (1gm dry wt.) then digested according to the procedure described by Goldberg et al (1983). Sediment samples were obtained by means of a Van Veen grab sampler from representative sites of marshes . (Trace metal analysis was performed on the <63 µm fraction of the sediment which had been separated by sieving after freez-drying and grinding and determined by the procedure described by Sturgeon et al. (1982)) using atomic absorption spectrometer (AA-630-12). Blank values were negligible for all metals studied . To check the possible loss of trace metals during sample processing , quality control samples containing known amounts of trace metals in biota and sediments , supplied by U.S. Environmental Protection Agency (U.S.E.PA) were processed and analyzed . The results of triplicate analysis agreed with the literature values to within 5%.



Fig(1): Map of the Southern Iraqi Marshes (Al-Hawizah and Al-Hamar) showing the samples stations.

3-Results and Discussion

Aquatic plants have been shown to accumulate heavy metals in their tissues and therefore have been used as biological indicators for metal pollution monitoring in the aquatic ecosystem. Tables 1 and 2 show the distribution of heavy metals in aquatic plants of Al-Hawizah and Al-Hammar marshes respectively. Lead showed the lowest concentrations <1.0 µg/g, followed by cadmium (0.55–1.3 µg/g) while Iron have shown the highest levels in most species with a considerable wide range of variation, from 2.5 µg/g in *P. nodosus* species to 10,700 µg/g in *Salicornia herbaceal* species. The other metals are generally arranged in the following order of abundance: Mn > Zn > Cu. The variability in the levels of heavy metals in different regions could be attributed to the biological variation between the species rather than environmental factors.

Table(1): Concentrations of trace metals in aquatic plants tissues (µg/gm dry wt.) of Al-Hawizah marsh ,Iraq.

Plants	Pb	Cd	Zn	Fe	Mn	Cu
P. Crispus	0.95	0.85	1.2	5.8	3.3	0.77
P. nodosus	0.81	0.55	0.95	2.5	2.6	0.96
Ceratophyllum demersum,	0.88	0.96	2.2	3.5	2.9	1.9
Salvinia.natans,	0.91	1.8	1.3	4.0	1.7	1.4
Potamogeton pectinatans	0.87	1.2	1.5	3.0	1.3	1.8
Salicornia herbaceal	0.96	ND	2.0	2.7	4.4	2.5
Vallisneria spiralis .	1.3	1.3	3.0	3.1	2.7	0.85

Table(2): Concentrations of trace metals in aquatic plants tissues (µg/gm dry wt.) of Al-Hammar marsh , Iraq.

Plants	Pb	Cd	Zn	Fe	Mn	Cu
P. Crispus	1.10	0.93	0.90	3.6	4.0	1.04
P. nodosus	1.21	1.55	1.05	3.9	1.5	0.88
Ceratophyllum demersum,	0.78	0.90	1.77	2.5	1.8	2.11
Salvinia.natans,	0.81	0.75	2.5	3.0	2.6	0.85
Potamogeton pectinatans	1.07	1.03	1.22	2.66	0.99	0.72
Salicornia herbaceal	0.66	2.4	3.0	3.44	4.6	3.5
Vallisneria spiralis .	1.0	2.1	3.38	3.26	1.55	1.34

In sediment samples , total concentrations of Cd, Pb, Cu, Zn, Mn and Fe were found to be 125, 2233, 527,114, 241 and 147 µg/gm respectively in Al-Hawizah marsh and 88 , 1244 , 397 , 330 ,228 and 124 µg/gm respectively in Al-Hammar marsh , generally these concentrations were higher than those found in the aquatic plants, the sediment composition and its movement (churn, eluviation of sediments) influences the content of these metals in sediment.

The levels of heavy metals in sediment and aquatic plants from Al-Hawizah and Al-Hammar marshes are presented alongside data from some other areas of the world in Table 3 and 4 . Comparison of such data may be difficult since data calculated for the whole southern region of Iraq are being judged in relation to selected individual areas and sites of the world which may not be representative for their regions. Moreover, different species of aquatic plants and fractions of sediments were analyzed. Also, information on weight is often lacking, and comparison is further complicated by the differences in data presentation. For example, analytical results may be presented as means or ranges on a dry or wet weight basis. With the exception of lead, surface sediments also had comparable or relatively low contents of Cd, Cu and Zn. Admittedly; these comparisons are based on data which exclude hot spots. No significant difference were observed in heavy metals concentrations in aquatic plants and sediment samples for both Al-Hawizah and Al-Hammar marshes However, the low occurrence of heavy metals in Al-Hawizah and Al-Hammar aquatic environments indicate low inputs of contaminants containing trace metals, compared to the more industrialized regions.

The above not with standing, the occurrence of trace metals in Al-Hawizah and Al-Hammar aquatic systems is not excessive when compared to some other areas of the world.

Table(3) : Mean metal concentrations in aquatic plants from Al-Hawizah and Al-Hammar marshes with other areas of the world (µg/g dry weight)

Location	Cd	Pb	Cu	Zn	Mn	Fe	References
Al-Hawizah Marsh *Ceratophyllum demersum*	0.96	0.88	2.2	3.5	2.9	1.9	Present Study
Al-Hammar Marsh *Ceratophyllum demersum*	0.90	0.78	2.11	1.77	1.8	2.5	Present Study
Al-Hammar Marsh *Ceratophyllum demersum*	ND	0.33	2.11	0.1	3.1	15.0	Al-Saad et al 1994
River Nile, Egypt							
Ceratophyllum (clean site)	<0.05	2.7	2.7	13.8			Fayed and Abd El-Shafy, 1985
Ceratophyllum (industrial site)	0.30	22.2	36.4	117.0			Fayed and Abd El-Shafy, 1985
Lower Volta River, Ghana							
Ceratophyllum	0.99	17.4	12.2	45.4	3332	2579	Biney, 1991
Pistia stratiotes	0.93	22.6	12.6	39.8	2259	3852	Biney, 1991
Potamogeton octandrus	<0.20	9.4	5.3	12.5	2370	1113	Biney, 1991
Vallisneria aethiopica	1.33	23.2	12.6	42.9	1809	3560	Biney, 1991
Lake Mcllwaine, Zimbabwe							
Blue-green algae	1.5	78		190	220		Greichus *et al.*, 1978
Harbeespoort Dam, S. Africa							
Algae	0.06	<0.10	2.7	39.0	96		Greichus *et al.*, 1977
Eichhornia	0.23	2.6	12.0	42.0	840		Greichus *et al.*, 1977
Accra, Ghana							
Ulva fasciatus (Green algae)	<0.2	8.3	6.9	24.8		163	EMA, 1989
Sargassum vulgare (Brown algae)	<0.2	8.5	7.2	37.8		342	EMA 1989
Polycavernosa dentata (Red Algae)	1.4	8.6	4.5	33.0		452	EMA1989

Table(4):Comparison of metal concentrations in sediment (µg/g dry weight)

Location	Cd	Pb	Cu	Zn	Reference
Al-Hawizah Marsh	88	1244	397	330	Present Study
Al-Hammar Marsh	125	2233	527	241	Present Study
North-east Ontario lakes			10.5–2900	130–448	Bradley and Morris, 1986
Narragansett Bay, USA	0.06–2.45	17–81	36–98	53–168	Eisler, 1977
River Tawe, Wales	39	862	326	5107	Vivian and Massie, 1977
Liverpool Dock, UK		109–613	90–1592	734–2087	Bellinger and Benham, 1987
Portsmouth Habour, UK	0.5–3.3	49–114	26–72	61–210	Soulsby *et al.*, 1978
Evoikos Gulf, Greece				52–147	Angelidis, 1981
Straits of Malaca	ND*-125	6.5–35-3	1.0–26.3		Sen Gupta,, 1990
Bahrain	0.02–0.05	1.70–15.1	5.60–10.0		Sen Gupta *et al*, 1990
Kuwait	0.09–0.23	3.3–68	20.1–21.9		Sen Gupta, 1990
Saudi Arabia	2.5–5.0	0.6–4.2	5.4–16.6	4.0–23	Linden, 1990
Hong Kong			22	96	Gomez, 1990
South China Sea	0.41–2.39		1.94–9.21	12.5–49.9	Gomez, 1990
Jakarta Bay	5.0–400		10–780	60–7140	Gomez, 1990
Wellington Habour, New Zealand		22–6740	15–216	55–2270	Brodie, 1990
Fiji	1.1–2.2	6.8–10	85–150	54–220	Brodie, 1990

* ND - Not Detected

4-Conclusions

According to the low concentrations of trace metals in the aquatic plants and surface sediments of Al-Hawizah and Al-Hammar marshes ;the study regions were unpolluted for the studied metals .The variability in the levels of trace metals in different plant species could be ascribed to biological variation between them rather than environmental factors. Despite this inadequacy, some conclusions could be drawn from this work . Generally, lower concentrations of heavy metals occur in Al-Hawizah and Al-Hammar aquatic systems compared to other areas of the world. With the expected increases in urbanization and socio-economic activities, there is a need to identify the sources and quantity of heavy metals discharges into aquatic environments on a national basis. It is also important to formulate pollution control measures in each country which should cover legislation, standards and criteria, waste minimization, effluent treatment, monitoring, training, education and public awareness.

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تراكيز العناصر النزرة في النباتات المائية ورواسب اهوار جنوب العراق (الحويزة والحمار)

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الملخص

اهتمت الدراسة الحالية بتحليل العناصر النزرة: الرصاص ،الكادميوم ، الخارصين ، النحاس ، المنغنيز والحديد في نماذج ستة أصناف من النباتات المائية ونماذج من الرواسب في هور الحويزة وهور الحمار. وجد أن طبيعة منطقة الدراسة غير ملوثة بهذه العناصر. ان قدرة هذه النباتات على احتواء هذه العناصر النزرة بالنسبة الى تركيزها في المحيط أدى الى التنوع في تراكيز هذه العناصر فيها. .بينت الدراسة ارتفاع تركيز العناصر في نماذج الرواسب مقارنة مع النباتات المائية. لم يلاحظ وجود إختلاف معنوي في تراكيز العناصر النزرة المدروسة في النباتات المائية والرواسب في كل من منطقتي هور الحويزة وهور الحمار. عموما ان مستوى العناصر المدروسة في النباتات المائية والرواسب السطحية في منطقة الدراسة أوطأ من مستواها في مناطق أخرى من العالم.