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# Heavy metals pollution of two hyper-saline lagoons, Lake Malaha East Port-Said, Egypt

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## Abstract

Heavy metals pollution is common problem in many lakes of Egypt, so this research aimed to assess this problem in Lake Malaha. Twenty-four samples taken from water and sediments of the lagoons of Lake Malaha. The water samples were collected and preserved by storing in acid-washed polyethylene bottles, sediment samples were collected and then kept in cleaned plastic bags and chilled on ice box. The chemical analysis for either water samples or sediment samples was assessed. The measured metals were Cr, Fe, Cd, and Zn, Ba and Pb. The obtained results showed that all concentrations of the measured heavy metals were within the permissible limits, this motivates us to maintain the lake and manage it in a good environmental manner and this will be a benefit for increasing fisheries and maintain biodiversity.

*Keywords*: Heavy metals, Pollution, Lake, Water, Sediment, Mediterranean, Sinai.

## Introduction

Heavy metals in the aquatic environment are usually monitored by measured concentrations in water, sediments and biota. Determination of heavy metals concentrations in surface water samples is difficult because of the concentrations is low, also display wide fluctuation **(Mastala *et al*., 1992).** The contamination by heavy metals in the aquatic environments has drawn particular attentions due to their toxicity, persistence and biological accumulation **(Zahran *et al*., 2015)**. In aquatic systems, heavy metals have received considerable attention due to their toxicity and accumulation in biota **(Mason, 1991)**. The most anthropogenic sources of metals are industrial, petroleum contamination and sewage disposal (**Liaghati *et al*., 2003).** The impact of such heavy metals abnormality may extend to involve the water quality and food web, and hence to the human health **(El-Badry, 2016).** Some of these metals, such as Cd and Pb, are toxic to living organisms even at quite low concentrations, whereas others, such as Zn and Cu, are biologically essential and natural constituents of aquatic ecosystems, and generally only become toxic at very high concentrations. Zn has a multitude of biological functions in the human body. It is an important constituent of over 100 enzymes involved in a variety of fundamental metabolic processes. It is involved in the production and function of several hormones. Excessive intake of Zn causes abdominal pain, violent vomiting, collapse, and degenerative changes in the liver. Cd is considered the most toxic element to human life. It causes itai-itai, a bone disease similar to rickets, and cardiac enlargement, anemia, gonadal atrophy, kidney failure and pulmonary emphysema. Pb is toxic and a major hazard to man and animals. Poisoning by lead causes anemia, encephalopathy, weight and coordination loss, abdominal pain, vomiting, constipation, and insomnia **(Khallaf *et al*., 1998).** chromium (Cr) which is its sources entering the aquatic environment from paint and chemical works, oil drilling and recovery rigs, large quantities of chromium may be released from petrochemical industries and cement, fertilizer, power, and chlor-alkali plants **(Zahran *et al*., 2015)**. Iron is the second most abundant metal and fourth most abundant element in the Earth's crust **(Taylor, 1964)**, but its concentration in water is quite low because of low solubility **(Molot and Dillon, 2003)**. Barium is Toxic; used in rat poison. In moderate to large concentrations can cause death; smaller concentrations cause damage to the heart, blood vessels, and nerves **(EPA, 1994a).** Sediment quality is a good indicator of pollution in water column, where it tends to concentrate the heavy metals and other organic pollutants **(Saeed and Shaker, 2008).** There are high quantities of heavy metal pollution of lakes in Egypt such this pollution that (Fe, Mn, Cd and Pb in Lake Manzala) and (Mn and Pb in Lake Borollus) recorded levels above the international permissible limits in water. In sediment samples (Mn in Lake Edku) and (Cd in Lake Manzala) recorded higher values than the sediment quality guidelines **(Saeed and Shaker, 2008).** Manzala Lake is highly contaminated with Fe, Cd, Pb and Cr due to the continuous discharge of different pollutants into it. It can also be concluded that the southern drains namely, Bahr El-Baqar, Ramsis, El-Matria, Hadous, Faraskur, El-Serw and Lissa El-Gamalia play an important role in causing a severe pollution in Manzala Lake **(Zahran *et al*., 2015).**

The main objective of this study is to assess heavy metals pollution in the two hyper-saline lagoons of Lake Malaha through determining the accumulation of Cr, Fe, Cd, and Zn, Ba and Pb in water and sediments of those lagoons, this obtained results will be useful for credible management of the two lagoons.

## Martials and Methods

### *2.1. Study area*

Lake Malaha lies in the northwestern corner of El-Tina plain, east of Port Fouad city and directly east of the Suez Canal between Longitudes: 32° 21` 30`` & 32 ° 30` E and Latitudes: 31° 7` & 31 ° 13` N **(Fig. 1).** Lake Malaha has a triangular shape and connected with the Mediterranean Sea by a small inlet near Port-Fouad and other shallow tidal inlets. The surface area decreased from 33,000 to 21,000 feddans after 1976 conflict, as the result of the construction of a road between Rommana and kilometer 19th on the Suez Canal. Lake Malaha consists of two shallow hyper-saline lagoons, the size and shape of which are variable; they reach the maximum size during winter and become nearly dry in summer season. The lagoons are connected to the Mediterranean Sea via Boughaze El-Kalaa (Eastern lagoon) and Boughaze El-Malaha (Western lagoon). The two lagoons are separated from the Mediterranean Sea by a sandbar that varies in width between 100 to 500 m **(Ahmed and El-Mor, 2006)**. There is no freshwater influx in the lake **(Hanafy *et al*., 1996)**.

Lake Malaha is one of the most important water bodies along the northern coast of Egypt for its fisheries resources. It represents an important rout for migratory birds. The present area of Lake Malaha is 11.43 km2 while it was 19.86 km2 in 2005, this is because of the changes and expansions carried out in east Port Said area. Also as a result of these expansions and projects in this area, the western area of the lake is bridged.

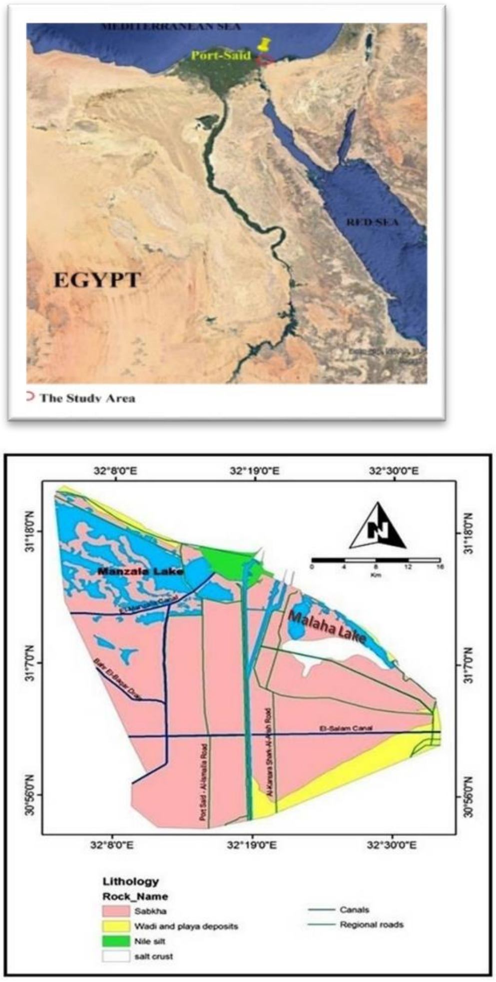


**Fig.(1):** Location map of Lake Malaha

*2.2. Sampling and analysis: -*

Sampling occurred in two lagoons of the lake, the western lagoon and eastern lagoon as showed in **(Fig. 2).**

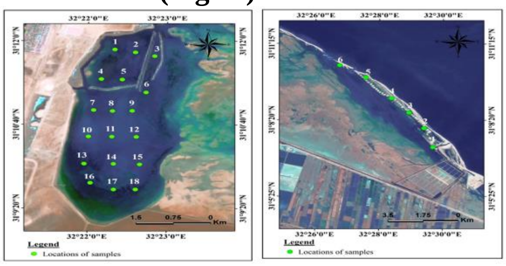


**Fig. (2):** Sampling in the two lagoons (western and eastern) of Lake Malaha

*2.2.1. Sampling and analysis of water: -*

In October 2015, 18 water samples were taken from different stations covered the western lagoon completely. Geographic positions of these samples were appointed using the GPS device. In October 2016, six water samples were taken from different stations in the eastern lagoon**.** Sampling was carried out according to the standard methods for examination of water and wastewater (**APHA, 2005**). Water samples were collected and then stored in acid-washed polyethylene bottles for heavy metals analyses. The water analyses for heavy metals were carried out in the laboratories of the Chemical Warfare Management, Armored Forces for detecting the heavy metals; Cr, Fe, Cd, Zn, Ba and Pb. The analyses procedures are carried out according to the laboratory schemes after preparing the collected samples. Samples were being filtered using filtration system through 0.45 μm-pore-diameter filter paper then analyzed for trace elements using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) with ultrasonic nebulizer (USN), this Nebulizer decrease the instrumental detection limits by 10%, this ICP instrument is Perkin Elmer Optima 3000, USA **(APHA, 2005).**

*2.2.2. Sampling and analysis of sediments:*

Eighteen sediment samples were collected at the same stations of the water samples in the western lagoon using core sampler. Six sediments samples were collected from the sediments at the same stations of the water samples in the eastern lagoon using hand, then kept in cleaned plastic bags and chilled on ice box for transport to the laboratories of the Chemical Warfare Management, Armored Forces, for heavy metals analysis. The samples were air dried at room temperature (25°C ± 2), crushed and finely grounded, sieved through (0.2 mm) sieve and kept for heavy metals analysis according to (**APHA, 2005**), The heavy metals measured were that Cr, Fe, Cd, Zn, Ba and Pb.

**Results and discussion: -**

*3.1. Heavy metals in water samples: -*

As showed in **(Table 1)** the average of chromium concentration in the western lagoon is 0.006 mg/l, while in the eastern lagoon is 0.001. The maximum contaminant level of Cr is 0.1 mg/l **(EPA, 1994a)**, which is meant the concentration of

Cr is within the permissible limits. The average of Iron (Fe) in the western lagoon as showed in **(Table 1)** is 0.084 mg/l, while in the eastern lagoon is 0.014 mg/l. The permissible limit of Fe is 1mg/l **(USEPA, 1986)** that meant the concentration of Fe is within the permissible limits. The average of cadmium concentration in the western lagoon is 0.003 mg/l while in the eastern lagoon is less than 0.001 mg/l as illustrated in **(Table 1)**. The maximum contaminant level of Cd is 0.005 mg/l **(EPA, 1994a)** that meant that the concentration of Cd in the two lagoons is within these limits. There is no detectable zinc concentration in the western lagoon while in the eastern lagoon the average concentration of Zn is less than 0.001 mg/l as showed in **(Table 1)**. The permissible limit of Zn is 1 mg/l **(USEPA, 1986**); that meant the concentration of Zn in the two lagoons is within that limit. The average of barium concentration in the western lagoon is 0.016 mg/l while in the eastern is 0.023 mg/l as showed in **(Table 1)**. The maximum contaminant level of Ba is 2 mg/l **(EPA, 1994a)** that meant that the concentration of Ba is within this limit**.** As showed in **(Table 1)** in the western lagoon, there isn't detectable lead concentrations while in the eastern lagoon is less than 0.003 mg/l. The permissible limit of Pb is 0.05 mg/l **(USEPA, 1986)** that meant the concentration of Pb is within that limit.

**Table (1):** Concentration of heavy metals in water samples in the two lagoons of Lake Malaha

| Area | | Chromium | Iron | Cadmium | Zinc | Barium | Lead |
|---|---|---|---|---|---|---|---|
| | | Concentration in mg/l (ppm) | | | | | |
| **Western lagoon** | Range | 0.005-0.008 | 0.066-0.13 | Nil-0.032 | Nil | 0.012-0.019 | Nil |
| | Mean | 0.006 | 0.084 | 0.003 | Nil | 0.016 | Nil |
| | SE (±) | 0.001 | 0.015 | 0.001 | 0 | 0.001 | 0 |
| **Eastern lagoon** | Range | <0.001-0.002 | <0.008-0.014 | <0.001 | <0.001 | 0.008-0.039 | <0.003 |
| | Mean | 0.001 | 0.014 | 0 | 0 | 0.023 | 0 |
| | SE (±) | 0.001 | 0.005 | 0 | 0 | 0.010 | 0 |

*3.2. Heavy metals in sediment samples: -*

For the western lagoon, the average of Cr concentration is 0.001 ppm while in the eastern lagoon is 0.074 ppm as showed in **(Table 2).** The maximum permissible limit of Cr in sediment is 0.5ppm **(Kabata-Pendias, 1995)**; this meant that cadmium concentration is within that limit. The average of Fe concentration in the western lagoon is 0.008 ppm while in the eastern lagoon is 6.98 ppm a showed in **(Table 2)**. The permissible limit of Fe in sediments is 20 ppm **(DPR, 2002 and FEPA, 2003)**; this meant that Fe concentration in the two lagoons is within that limit. As showed in **(Table 2) the** average concentration of Cd in the western lagoon is less than 0.001ppm while in the eastern lagoon is 0.001ppm. The maximum permissible limit of Cd in sediment is 0.5ppm **(Kabata-Pendias, 1995)**; this meant that cadmium concentration is within that limit. The average of Zn concentration in the western lagoon is less than 0.001 ppm while in the eastern lagoon is 0. 190 ppm as showed in **(Table 2).** The severe effect level of Zn in sediments is 820 ppm **(Persaud *et al*., 1993**) this meant that Zn concentration is within that limit. As showed in **(Table 2)** the barium concentration average in the western lagoon is 0.023ppm while in the eastern lagoon is 0.040ppm. As showed in **(Table 2)** the average of Pb concentration in the western lagoon is less than 0.003 ppm while in the eastern lagoon is 0.028ppm. the severe effect level of Pb in sediment is 250 ppm **(Persaud *et al*., 1993),** so the concentration of Pb in sediment samples had no severe effect.

**Table (2):** Concentrations of heavy metals in sediment samples of the two lagoons of Lake Malaha

| Area | | Chromium | Iron | Cadmium | Zinc | Barium | Lead |
|---|---|---|---|---|---|---|---|
| | | Concentration in (ppm) | | | | | |
| Western lagoon | Range | 0.001-0.002 | 0.008-0.009 | <0.001 | <0.001 | 0.008-0.039 | <0.003 |
| | Mean | 0.001 | 0.009 | 0 | 0 | 0.023 | 0 |
| | SE (±) | 0.0005 | 0.0008 | 0 | 0 | 0.0124 | 0 |
| Eastern lagoon | Range | 0.046 | 3.512 | 0.001 | 0.118 | 0.017 | 0.015 |
| | Mean | 0.074 | 6.98 | 0.001 | 0.190 | 0.040 | 0.028 |
| | SE (±) | 0.036 | 3.264 | 0.0005 | 0.074 | 0.028 | 0.015 |

The present study shows that the quality degree of Lake Malaha environment is good and suitable for the growth of fish and aquatic organisms and also the lake is a suitable habitat for migratory birds. The two lagoons of the lake have good habitat and environment because the concentration of analyzed heavy metals rather in water or sediments is within the standards and permissible limits.

## Conclusion:

Lake Malaha is one of the most important water bodies along the northern coast of Egypt for its fisheries resources. It represents an important rout for migratory birds. It consists of two hyper-saline lagoons, Western lagoon and Eastern lagoon. At the present time, the western lagoon is disappeared because of the projects and expansions at the eastern Port Said area. In this search an assessment of these two lagoons was performed through analysis of heavy metals for water and sediment. These heavy metals were Cr, Fe, Cd, Zn, Ba and Pb. Through the analysis, it was showed that Lake Malaha has a good environment and habitat, also it is suitable for the growth of fish and aquatic organisms, a fit habitat for migratory birds and it is a resource for fisheries and increasing the national income, so we recommended that a lot of interest is given for the remnant lagoon (the eastern one) and great efforts and cooperation between different authorities are needed to protect the lake from any pollution, conserve and maintain it.

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## الملخص العربي

**عنوان البحث:** التلوث بالعناصر الثقيلة فى بحيرتين شديدتين الملوحة لبحيرة الملاحة شرق بورسعيد ، مصر

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**تعتبر بحيرة الملاحة من اهم المسطحات المائية علي الساحل الشمالي لمصر كمصدر من مصادر الثروة السمكية ، كما تعتبر من الطرق الهامة للطيور المهاجرة.**
**تتكون البحيرة من بحيرتين شديدتين الملوحة واحدة ناحية الغرب والاخري ناحية الغرب وفي الاوئنة الأخيرة تم ردم البحيرة الغربية نتيجة للمشاريع والتوسعات التي أقيمت في منطقة شرق بورسعيد، في هذه الدراسة تم تقييم بحيرة الملاحة من خلال تحاليل المعادن الثقيلة في كلا من مياه وتربة هاتين البحيرتتن الصغيرتين المكونتين للبحيرة وذلك بسبب زيادة التلوث بالمعادن الثقيلة في كثير من بحيرات مصر كالتلوث الموجود في بحيرة المنزلة.**
**فمن خلال نتيجة التحاليل التي أجريت علي مياه وتربة البحيرة تم استنتاج ان البحيرة تتمتع ببيئة جيدة صالحة لنمو الأسماك ومصدر للثرة السمكية الذي يؤدي لزيادة الدخل القومي و كموطن للطيور المائية والتنوع البيولوجي ولذلك نوصي بكثير من الاهتمام للبحيرة المتبقية (البحيرة الشرقية) ، أيضا فأن البحيرة بحاجة الي كثير من المجهودات والتعاون بين السلطات المختلفة بهدف صيانتها والحفاظ علي بقائها.**