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Full Length Research Paper

Water quality assessment of Manchar Lake during the month of August and November 2011 by analyzing selected trace elements

Ghulam Murtaza Mastoi[1], Khalid Hussain Lashari[2], Zameer Ali Palh[2]*, Anila Naz Soomro[2], Zulfiqar Ali Laghari[3], Khalida Faryal Almani[1], Gul- e-Rana Abdul Waheed Mastoi[1] and Abdul Rasool Abbasi[2]

[1]Centre for Environmental Sciences, University of Sindh, Jamshoro, Sindh, Pakistan.
[2]Department of Fresh Water Biology and Fisheries, University of Sindh, Jamshoro, Sindh, Pakistan.
[3]Department of Physiology, University of Sindh, Jamshoro, Sindh, Pakistan.

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Manchar Lake is the largest fresh water lake in Pakistan, situated in Jamshoro District. It was created in the 1930 when the Sukkur Barrage was constructed on the river Indus. It is a vast natural depression flanked by Khirthar range in the west, Lakhi hills in south and river Indus in the east. On the north eastern side is the protective embankment. The lake is fed by two canals, the Aral Wah and the Danister from the river Indus. The lake also collects water from numerous small streams in the Khirthar Mountains. The area of the lake fluctuates during the flood season from 350 to 520 km^2. The mean depth of the lake is at present 13 feet. Contamination of Manchar Lake is serious issue of aquatic pollution. Lake gets polluted by different waves although it is a second largest lake of Sindh province. Untreated damping of industrial liquid waste is one of the main causes of its pollution, hence for the justification of its contamination some trace metals, Lead, Copper, Zinic, Cobalt, Chromium and Nickel were analyzed by dual mode of analytical methods flame atomic absorption spectrometry (FAAS) and electro thermal atomic absorption spectrometry (ETAAS) by multi element stranded solution. The highest concentration of Lead, Copper, Zinic, Cobalt, Chromium and Nickel were 54.5 and 58.5 µg/L, 115 and 117.5 µg/L, 3000 and 3200 µg/L, 7 and 9.5 µg/L, 90 and 95.5 µg/L, 90 and 117 µg/L in month of August and November, 2011 respectively (Pb, Cu, Zn, Co, Ni, and Cr) were selected for study.

Key words: Contamination, waste, pollution, environment, fresh water.

INTRODUCTION

The pollution of Manchar Lake is serious issue, various studies has been carried out on Manchar Lake (Arain et al., 2008; Kazi et al., 2009; Arain et al., 2009; Abdul et al., 2009). We know that water is essential for sustaining the life on planet earth. This vital resource makes up more than 60% of the living organisms. Pollutant derived from

*Corresponding author. E-mail: zameer_ali110@hotmail.com

a growing number of diverse sources (Industrial waste, urban run-off, sewage treatment plants, boating activities, agricultural fungicides, domestic garbage, dumps, anthropogenic activities and mining operations) have increasingly affected aquatic ecosystem (Garrett, 2000; Lashari et al., 2012). Heavy metals aquatic system have attracted considerable attention owing to their toxicity and accumulation in aquatic biota (Elllis 1989; Mason, 1998). The human health is directly concern to the quality of water, sanitation and hygiene. Water required for human consumption must be free from concentration of chemical substances that may be health hazards; as water is highly prone to contamination by bacteria, viruses, protozoa, pathogens, helminthes parasite, and toxic organic, inorganic compounds (Hari et al., 1994; Miranzadeh et al., 2011). Polluted water causes various diseases in consumers such as, diarrhea, dysentery, typhoid, cholera, hepatitis etc (Waheed and Kausar, 1987). The children under the age five have been killed by waterborne diseases and it is reported that the death ratio due to unsafe water is more than all forms of violence including war worldwide annually (World health organization, 1996, 2003). Amongst the water borne diseases diarrhea is considered as one of the major killer among the children. Each year 1.8 million people die from diarrhoeal diseases, and 90% of these deaths are of children under five (World health organization, 2003; WHO/UNICEF, 2004). Moreover, each year 4 billion cases of diarrhea has been reported worldwide and results in 2.2 million deaths occurred mostly of the children under five. This shows that 15% of child deaths every year are attributable to this dreadful disease. It is reported that child is dying every 15 s because of diarrhea worldwide. In India, half million children has dying each year due to diarrhea (UNICEF, WHO, 2009). As, in Pakistan fifty thousands three hundreds children under five year are dying due to diarrhea annually; and Pakistan is ranked sixth among fifteen countries (WHO/UNICEF, 2004). In the source of Industrialization, the quantity of heavy metals and toxic compounds are continuously released into Manchar Lake, hence, the aim of current study was to investigate the heavy metals content from Manchar lake water.

MATERIALS AND METHODS

In the study area of the Manchar lake five sampling stations was selected which includes zero points (waste entrance point into lake), near to zero point (inside the Manchar lake), mid of the Manchar, Danistar Wah (Manchar Lake) and Aral Wah (Manchar Lake) respectively. Sampling was carried out throughout the year; which includes August, 2011, November, 2011. Each sampling was carried out after the interval of three months. Water samples were collected according to the method of in pre-cleaned one liter plastic bottles of scraped caps. The sample bottle was plunged necks downwards about 15 cm below the water surface and about 60 cm from the side of local fisher man boats. The samples were stored in the laboratory at the room temperature on top of cupboards until required for use. All the analyses were conducted according to the standards of American Public Health Association (APHA, 1992). The entire chemicals and study standards solution were obtained from Sigma Fluka.

RESULTS AND DISCUSSION

Natural fresh water contains impurities of trace elements/heavy metals as it dissolves these substances while moving downward as a hydrological cycle (Aamir and Tahir, 2003). Metals can be lethal or harm the organism without killing it directly. Adverse effects on an organism's activity, growth, metabolism, and reproduction are examples of sub lethal effects (Wright and Pamela, 2002). These metals include lead (Pb), Cadmium (Cd), Zinc (Zn), Mercury (Hg), Arsenic (As), Silver (Ag) Chromium (Cr), Copper (Cu) Iron (Fe), and the Platinum group elements (Haijian et al., 2011). Many of these metals are considered essential for human health. Like Iron, Copper, Zinc, Nickel and other trace elements are needed for proper functioning of biological systems, but overexposure can lead to adverse health consequences (Rippey et al., 2008; Ley et al., 2011). However, deficiencies of these trace elements may lead to a number of disorders as well (Prabu, 2009). Generally heavy metal bioaccumulat during metabolic processes (Borgmann et al., 1993; Sharma and Aqrawal, 2005) and yet their biotoxic effects in human biochemistry are hugely unexplored (Duruibe et al., 2007). Their potential accumulation in biosystems and food chain has been documented. Thus a better understanding of heavy metal contamination profiles and their effect in water, soil and plant systems has attracted a lot of research interest (Prabu, 2009). In Pakistan toxic metals in both ground and surface waters, often exceed the maximum admissible concentrations recommended by WHO.

Cobalt

The result shows that maximum concentration of Cobalt was noted up to 7 µg/L in sample Station-1 in the month of August, 2011. However, at sampling Station-5 the minimum value of the cobalt was equal to 3 µg/L. The average value of the samples in the month of August noted 4.6 µg/L, whereas result obtained from the Month of November, 2011 was range as 4.5 to 9.5 µg/L. The average value in November was 7.1 µg/L (Tables 1 to 2). Cobalt content in Keenjhar Lake is Low as compare to that of Manchar Lake. Cobalt concentration were higher than that WHO/UNICEF (2004)) but our result are not in agreement with the result of Lashari et al. (2012) and Korai et al. (2008).

Lead

Child lead poisoning causes delayed brain development

Table 1. Heavy metals of Manchar Lake in the month of August 2011.

Sampling Stations	Co µg/L	Pb µg/L	Cr µg/L	Ni µg/L	Cu µg/L	Zn µg/L
MNVD 1	7	54.5	90	90	115	3000.90
Near zero point 2	5	52.5	25	30	110	3000
Mid of Manchar 3	6	50.5	50	15	100	3000.50
Danister wah 4	2	50	30	57	105.55	2000
Aral wah 5	3	51.5	70	60	90	2500
Average	4.6	51.8	53	50.4	104.11	2700.28
Max:	7	54.5	90	90	110	3000.90
Min:	2	50	25	15	90	2000
WHO Standards µg/L	N/A	0.05X1000= 50	0.05X1000= 50	0.02X1000 =20	1.0X1000 =100	3.0X1000 =3000

Table 2. Heavy Metals of Manchar Lake in the Month of November 2011.

Sampling Stations	Co µg/L	Pb µg/L	Cr µg/L	Ni µg/L	Cu µg/L	Zn µg/L
MNVD 1	9.5	58.5	95.5	92.5	117.5	3200
Near zero point 2	8.5	55.5	30.5	33.5	110.5	3100
Mid of Manchar 3	5.5	52.5	52.5	17.5	105.5	2300
Danister wah 4	7.5	45.5	30.5	63.5	107.55	3100
Aral wah 5	4.5	53.5	72.5	60.5	92.5	2700
Average	7.1	53.1	56.3	53.5	106.71	2880
Max:	9.5	58.5	95.5	92.5	117.5	3200
Min:	4.5	45.5	30.5	17.5	92.5	2700
WHO Standards µg/L	N/A	0.05X1000= 50	0.05X1000= 50	0.02X1000 =20	1.0X1000 =100	3.0X1000 =3000

or acute brain problems (Shi and Zhaoyu, 2008). It also affects the safety of aquatic organisms at a concentration of 0.16 mg/L. The result shows that maximum concentration of lead equal to 58.5 µg/L was found in sampling Station-1 of the Manchar Lake and minimum value equal to 45.5 µg/L in the month of August, 2011, (Tables 1 to 2). Maximum lead concentration of 0.235 µg/L and minimum lead concentration of 0.1 µg/L in Keenjhar Lake but Maximum lead concentration of 58.5 µg/L and minimum lead concentration of 45.5 µg/L in Manchar Lake, but our result are not agreement with the result of Lashari et al. (2012) and Korai et al. (2008).

Chromium

Chromium in humans causes mouth ulcers, nosebleeds, kidney disease, low white blood cell counts and a variety of cancers (Bradl, 2005; David and Pamela, 2002). The most bioavailable and most toxic form of chromium are the hexavalent ion Cr^{+6}. However, low concentrations of hexavalent chromium cause sub lethal toxic effects in aquatic plants and animals. For example, 62 ppb inhibits growth in algae and 16 ppb inhibits growth in chinook salmon (Taub, 2004). As is the case with other metals, chromium toxicity to aquatic organisms increases as water temperature increases and as pH and salinity decrease. Additionally, chromium is more toxic in soft water than in hard water. The concentration of chromium that caused death in 50% of the exposed population was 3 ppm in soft water and 72 ppm in hard water for fathead minnows and 18 ppm in soft water and 133 ppm in hard water for goldfish (Taub, 2004).

In the month of August the maximum concentration of chromium was found at Mid of Manchar sampling Station-1 which is equal to 90 µg/L and the minimum concentration was noted as 25 µg/L at near zero point sampling Stations-2. The average value was 53 µg/L in the August, 2011. Where is during same year in the month of November, samples were collected from the same stations to know the concentration of metals in the Manchar Lake. The results shown that the maximum concentration of Chromium was found up to 95.5 to 30.5 µg/L at sampling station -1. The average value was found equal to 56.3 µg/L. Chromium content in Keenjhar Lake water was maximum 4.9 µg/L and minimum 1.8 µg/L but Chromium content in Manchar Lake was maximum 95 µg/L and minimum 25 µg/L. Chromium level was below in Keenjhar Lake and Chromium level was high in Manchar Lake (WHO/UNICEF, 2004) but our result are not agreement with the result of Lashari et al. (2012), Ansari et al. (2004) and Anazawa et al. (2004).

Nickel

There is evidence suggesting that nickel may be an essential trace element for mammals (Goyer, 1991). Nickel is primarily found combined with oxygen or sulphur as oxides or sulphides that occur naturally in the earth's crust. Nickel combined with other elements is present in all soils, in meteorites, and is emitted from volcanoes. As for most metals, the toxicity of nickel is dependent on the route of exposure and the solubility of the nickel compound (Coogan et al., 1989). The route of exposure may be inhalation, oral, or dermal and can be classified according to systemic, immunologic, neurologic, reproductive, developmental, or carcinogenic effects following acute (01 day), subchronic (10 to 100 days), and chronic (100 days or more) exposure periods. The most common harmful health effect of nickel in humans is an allergic skin reaction in those who are sensitive to nickel. The metal is not only an allergen but also a potential immunomodulatory and immunotoxic agent in humans (Das and Buchner, 2007). Based on studies of nickel workers and laboratory animals, all nickel compounds, except for metallic nickel, have been classified as human carcinogens by the International Agency for Research on Cancer (IARC, 1990) and the U.S. Department of Health and Human Services (DHHS, 1994).

In the month of August, 2011 maximum concentration of nickel was found at Sampling Station-1 which is equal to 90 µg/L and the minimum concentration was noted as 15 µg/L at sampling Station-3. The average value was 50 µg/L in the month of August, 2011. In the month of November the concentration of nickel ranged from 17.5 to 92.5µg/L. The average value was found equal to 53.5 µg/L (Tables 1 to 2). Maximum Nickle in Keenjhar Lake 39.5 µg/L and minimum3.5 µg/L but Nickle in Manchar Lake was maximum 92.5 µg/L and minimum 15 µg/L. Nickle level was below in Keenjhar Lake and Nickle level was high in Manchar Lake (WHO/UNICEF, 2004) but our result are not in agreement with the result of Aamir and Tahir (2003) and Lashari et al. (2012).

Copper

Copper is an essential trace nutrient that is required in small amounts (5 to 20 µg per gram (µg/g) by humans, other mammals, fish and shellfish for carbohydrate metabolism and the functioning of more than 30 enzymes. It is also needed for the formation of haemoglobin and haemocyanin, the oxygen-transporting pigments in the blood of vertebrates and shellfish respectively. Most toxic form of copper is the cupric ion (Cu^{2+}). However, copper concentrations that exceed 20 µg per gram (µg/g) can be toxic, as explained by Bradl (2005) and David and Pamela (2002). Fish and crustaceans are 10 to 100 times more sensitive to the toxic effects of copper than are mammals. As copper, effects on gills, liver and kidneys of the fishes and decrease the sperm count as well respectively. There are many biological effects from copper toxicity at different concentration. Such as, copper concentration of 0.01 mg/L can inhibit water self-purification; at a concentration of 0.0002 mg/L, water starts to become toxic for fish. Copper can remain in soil, so sewage irrigation or sludge fertilizer could easily lead to soil pollution, hinder root development, and inhibit nutrient absorption and growth. Copper toxicity also affects aquatic organisms; in coastal and harbor areas the presence of copper once caused green oyster events. Moreover, an epidemiological survey found that areas where drinking water contains high level of copper are correlated with high rates of deaths from cardiovascular problems. Symptoms of acute copper poisoning include: low blood pressure, vomiting, melena, jaundice, hemolytic anemia, and coma to death (Shi and Zhaoyu, 2008). Copper is used in alloys, tools, coins, jewelry, food and beverage containers, automobile brake pads, electrical wiring and electroplating respectively.

The concentration of copper in the month of August, 2011 ranged from 90 to 105.55 µg/L, whereas the average concentration in the same month was recorded as 104.11. The maximum concentration of Copper was found at Sampling Station-1, 115 µg/L and the minimum concentration was noted at sampling Station-5, 90 µg/L. In the month of November the average concentration of copper was recorded as 106.71 µg/L, the maximum concentration of Copper was 117.5 µg/L at sampling Station-1, whereas the minimum concentration was 92.5 µg/L at sampling Station-5. The concentration of copper is high 7.3 µg/L and low 0.6 µg/L in Keenjhar Lake, but the concentration of copper is high 117.5 µg/L and low 90 µg/L in Manchar Lake. Copper concentration were higher (WHO/UNICEF, 2004).

Zinc

The human body contains 2 to 3 g of zinc with the highest levels in muscles, liver, kidneys, bones and prostate. The recommended daily zinc intake is 12 mg/day for adult women and 15 mg/day for adult men. Daily intake is depending on sex, age and general health status. Like as growing infants, children, adolescents, and women in pregnancy and the elderly have a higher zinc requirement. The uptake of elements by organisms is required in an optimal concentration range. As, when uptake is too low, deficiency occurs this includes reduced sense of taste and smell, skin disorders, mental lethargy and reduced fertility. On the other side, uptake of too much of an essential element can lead to toxicity. Such as, high doses can lead to gastro-intestinal disorders It is found naturally in rocks, air, water and soil. The average natural level of zinc in the earth's crust is 70 mg/kg (dry

weight), ranging between 10 and 300 mg/kg (Malle, 1994).

The average concentration of Zinc in the month of August, 2011 was recorded as 2700.28 µg/L. The maximum concentration of Zinc was recorded at Sampling Station-1 which was up to 3000.90 µg/L and the minimum concentration was recorded at sampling Station-4, 2000 µg/L. Whereas, during same year 2011 in the month of November, the average concentration of Zinc was recorded as 2880 µg/L. In the month of November maximum concentration of zinc was recorded as 3200 µg/L sampling Station-1, whereas the minimum concentration of zinc was recorded as 2300 µg/L at sampling Station-3 (Tables 1 to 2). Zinc is high 104 µg/L and low 1.4 µg/L in Keenjhar Lake but zinc is high 3200 µg/L and low 2000 µg/L in Manchar Lake our result are not agreement with the result of Lashari et al. (2012), Ansari et al. (2004) and Anazawa et al. (2004).

Conclusion

From this study it was found that lake is contaminated with trace elements including lead, cobalt, zinc, nickel, copper and chromium. The concentration of these elements was high from the standard limit of World Health Organization. The aquatic organisms were found in danger other hand local human population is also at risk because they are utilizing the water of lake without any treatment. This lake also a major source of fishing and fish cached from lake may be highly contaminated by various toxic species. Hence it is highly recommended that government should take necessary steps to save the precious fresh water lake.

Conflict of Interest

The authors have not declared any conflict of interest.

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