Biological Forum – An International Journal 9(1): 95-99(2017)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

An Investigation on the toxicity of some trace metals in river Kabul, Khyber Pakhtunkhwa Province of Pakistan

Khalid Usman[*], Hameed Ur Rehman[***], Sundus Adeel[*], Wahid Shah[*], Khalid Pervaiz[**], Zahirullah[***], Rafi Ullah[***] and Muhammad Arsalan[***]

[*]*Department of Zoology, Hazara University, Mansehra, Pakistan*
[**]*Fisheries Research & Training Institute, Lahore, Pakistan*
[***]*Department of Chemistry, Kohat University of Science and Technology-26000, KPK, Pakistan.*

(Corresponding author: Hameed Ur Rehman)
(Received 08 December, 2016, Accepted 14 January, 2017)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A study was conducted to analyze the concentration of trace metals in natural waters of river Kabul, Khyber Pakhtunkhwa Province, Pakistan. The metals i.e., Pb, Cd, Zn, Mn, Cu and Cr were determined by using atomic absorption spectrophotometer. The concentrations of the metals recorded were in the range as: Pb 0.06-4.41 ppm; Zn 4.11-7.11 ppm; Cd 0.42-1.46 ppm; Cu 1.07-3.86 ppm; Mn 0.06-2.11 ppm and Cr 0.05-2.11 ppm. All the metals analyzed were above the international permissible limits except manganese. The high level of metal contamination in the river Kabul suggested that the water conditions are not suitable for aquatic life and human consumption.

Key Words: River Kabul, aquatic pollution, trace metals

INTRODUCTION

Pollution is often dependent upon the load of wastes coming from civilization development. Much of the waste of urban development enters the water bodies through of water borne discharge wastes termed as waste water (Welch and Jacoby, 2004). The waste water discharges by industrial operations, in some cases, are among the worst sources of water pollution. The nature of pollutants associated with these waste waters differs greatly from one industry to another, in almost all cases. The resulting problems are associated with one or more combination of factors, including high BOD, high conc. of suspended solids and presence of toxic substances, etc. (Edwards, 1993).

Water covers 71% of the earth's surface and make up 65% of the human body. Presently, 450 million populations in 29 different countries are facing the problem of water shortages (UNEP, 2002). Aquatic pollution has appeared as a serious problem in Pakistan due to the introduction of industrial effluents / domestic sewage and its continuous discharge into the water bodies containing high concentrations of toxic chemicals including heavy metals (Kosar and Javed, 2012). River Kabul has its origin in the Paghman Mountains in Afghanistan and enters Pakistan at Shalman in Khyber Agency. It then flows between Khyber and Mohmand Agencies till reaches Warsak Dam. Below the dam the river is divided into three main channels viz; Shah Alam, Naguman and Adezai as is evident from Fig.1 (Alvi, 2007). After flowing for 34 kms, these channels join together and flow as a single channel downstream for many kilometers before joining the river Indus at Kund, Attock (Yousafzai *et al*., 2007). Heavy metals are a health hazard to human and animal fauna if their level exceeds from their naturally occurring concentration. The concentration of heavy metals is the source of water pollution because they have the property to fix inside the water fauna (Harte *et al*., 1991). Encephalopathy is a primary reason of death in patients among mutually sensitive and continual heavy metal poisoning. Copper ions can originate food toxicity nuisance, vomiting, nausea and diarrhea at even lower doses (Knobeloch, 1994: Stenhammar, 1999). Mercury is highly volatile in nature and enters the water from industrial sources. The bacterial activities in water reservoirs such as river, lake and coastal water increase the mercury level in water and thus become a source of pollution (Murata *et al*., 2004). Mining is another vital source of water pollution. Toxic metals go into the water during the grinding process like the utilization of sedimentation ponds such as Pb and Zn ores usually contain the much more toxic Cd as a minor component. Cadmium metal is a major water pollutant (Kjellstrom, 1986). The use of water having Lead and Cadmium can cause severe fitness problems.

The existence of Pb and Cd in the soil, water indicates pollution in the water (Trieff, 1980). The existence of Lead on the water surface is due to anthropogenic activities which occur due to the fuels containing Lead, hydrometallurgical nonferrous metal manufacture and coal combustion. Lead in natural water is due to organic lead complexes initially coming from the fuel combustion from automobile sources and following by the breakdown of tetraethyl lead (Andrews & Sutherland, 2004: Monterroso *et al*., 2003).

MATERIALS AND METHODS

Nine different sites were selected on river Kabul for the collection of water samples (Table 1). Water samples were collected from the selected sites and stored in clean and labeled dry plastic bottles with screw caps. The freshly collected samples were analyzed for heavy metals at Pakistan Counsel for Scientific & Industrial Research / PCSIR laboratories of Peshawar by using atomic absorption Spectrophotometer. The stock solution was prepared as 1000 ppm = 1000 mg/l. The serial dilution equation C1V1 = C2V2. The river samples after filtration were subjected to analysis of Zn, Cu, Cd, Mn, Cr, Pb by atomic absorption spectrophotometer (Model: Z-2000; Hitachi, Tokyo, Japan) which gave direct results of heavy metals on a computerized system.

Table 1: Names of the Sampling Location Sites of River Kabul along with Coordinates.

Sr. No.	Site No.	Area Description	North latitude	East longitude
1	S-1	Warsak (1 Km downstream of Warsak dam)	34°09'59.23"	71°22'05.25"
2	S-2	Khazana Sugar Mill Peshawar	34°06'55.16"	71°36'49.58"
3	S-3	Toti Tannery waste Peshawar	34°07'19.78"	71°36'24.04"
4	S-4	Dalda Oil Mill Nowshera	34°01'02.57"	71°55'51.02"
5	S-5	Cantt Area Nowshera	34°00'40.24"	71°59'36.75"
6	S-6	Jehangera Upper	33°58'23.24"	72°12'44.27"
7	S-7	Jehangera Lower	33°57'51.81"	72°13'03.70"
8	S-8	Marble Factories Kund	33°55'42.52"	72°13'51.05"
9	S-9	Khairabad Attock	33°54'17.70"	72°14'04.93"

RESULTS AND DISCUSSION

Table 1 indicates the names of the sampling location sites of River Kabul along with their coordinates. These include Warsak (1 Km downstream of Warsak dam), Khazana Sugar Mill Peshawar, Toti Tannery waste Peshawar, Dalda Oil Mill Nowshera, Cantt Area Nowsehra, Jehangera Upper, Jehangera Lower, Marble Factories Kund and Khairabad Attock. The concentration of various heavy metals in water samples collected from nine different sites of the river were measured in ppm and given in Table 2 along with their permissible limits by WHO (1993). Fig. 1 is the Map of River Kabul showing its flow and indicating the nine points of sampling areas (Alvi, 2007). Fig. 1 – 10 represents the comparison of trace metals concentrations viz. Zn, Cu, Cd, Pb, Cr and Mn at these nine sites.

Table 2: Trace Metal Concentrations (ppm) in River Water along with its Permissible Limits.

Metals	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	*Permissible Limits
Zn	4.11	4.40	5.00	**7.11**	4.31	4.29	4.77	4.81	4.37	5.0 mg/l
Cu	1.07	2.23	2.11	3.11	3.27	**3.87**	2.36	2.89	1.00	0.05 mg/l
Cd	0.42	1.29	1.23	1.36	**1.46**	1.17	1.12	1.11	1.10	0.05 mg/l
Pb	0.06	**4.41**	3.27	2.11	1.36	1.23	1.19	1.28	1.12	0.05 mg/l
Cr	0.00	1.87	**2.11**	0.22	0.20	0.14	0.09	0.05	0.04	0.05 mg/l
Mn	0.06	1.00	0.86	**2.11**	0.00	0.36	0.47	0.72	0.40	50-70 mg/l

*After WHO, 1993

(Metals with sites at highest concentration are depicted in bold)

The highest value of Zn was recorded at S-4 / Dalda Oil Mill Nowshera (7.11ppm), while the lowest Zinc value is that of S-1 / Warsak Area (4.11 ppm) while the rest of the samples have Zinc values between these two limits 4.11-7.11 ppm.

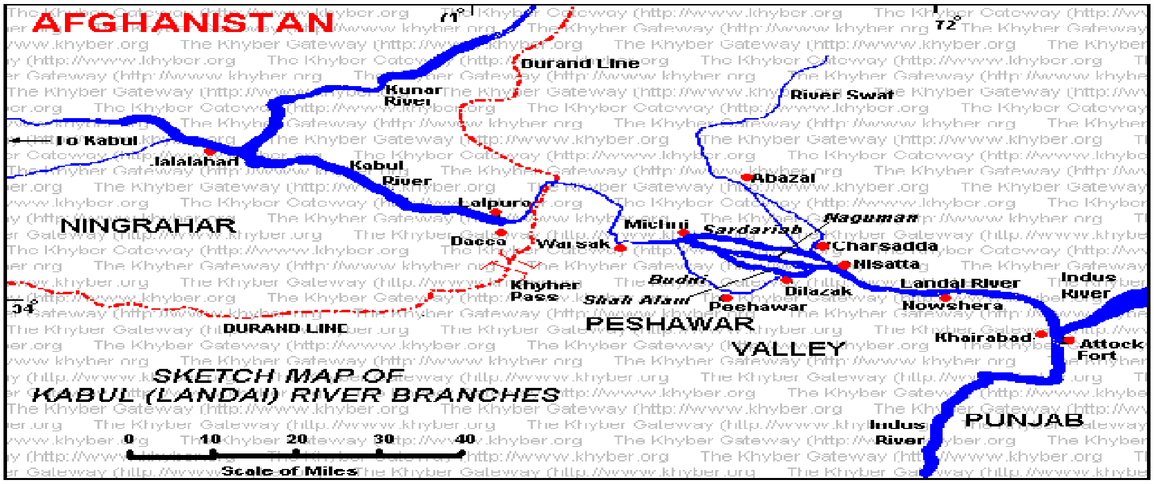

Fig. 1. Map of River Kabul (Alvi, 2007).

A study was conducted by Jaleel *et al.* (1996) at river Indus and Zn range recorded was 0.010-0.174 ppm, which was lower than the present result. The highest value of Zn is due to the Zinc Nitrite primarily present in soil. After absorption by plants seed of these plants are used in oil mill for clarification process this Zinc Nitrite is then discharged to the River water along its effluent which are the main reason of Zinc accumulation in the River water. After accumulation in fishes, their effect on its growth rate and ultimately these fishes are used by human beings which become a health hazard.

The highest value of Cu was recorded at S-6 / Jehangira Upper (3.87 ppm), while the lowest Cu value recorded at S-1 / Warsak Area (1.07 ppm) and the rest of the samples have Cu values between these two limits 1.07-3.87 ppm. A study was conducted by Jaleel *et al.* (1996) at river Indus and Cu range recorded was 0.24 mg/l, which was lower than the present study. The highest value of Cu was due to the usage of Copper acetate, Copper chromate as fungicides and Copper methane arsenate as an algaecide entering into the water body at different places. Since these are used for the protection of plants and field crops to gain maximum production.

The highest Pb value was found at S-2 / Khazana Sugar Mill Peshawar (4.41 ppm), while the lowest Pb value was recorded at site 9 (0.06 ppm) and the rest of the samples have Pb values between these two limits 0.06-4.41 ppm. Jaleel *et al*. (1696) conducted a study at river Kabul and recorded Pb range 0.013–0.160 ppm, which was lower than the present study. The higher value of Pb is due to the high level of lead in air emitted by a large number of vehicles coming from the tetraethyl lead (TEL) used in petrol at Peshawar which is absorbed by water of river Kabul.

The highest value of Cr was recorded at S-8 / Kund marble factory (2.11 ppm) while the lowest Cr value was that of S-9 / Khairabad Attock (0.04 ppm) and the rest of the samples have values between these two limits 0.04-2.11 ppm, Sidky (2003) recorded the Cr value between 1.20 -2.70 ppm in Lake Qarun and Wadi-El-Rayan Wetland (Egypt) water, which was higher than the present study. The highest value of Cr was due to the use of chromium salt in tanning process which then through the effluent discharge of the tannery flow into the River. Here accumulation of chromium takes place which is not suitable for the water quality and also adversely affect the aquatic fauna. Chromium becomes lethal when its concentration exceed from the normal range.

The highest concentration of Mn was found at S-4 / Dalda Oil Mill Nowshera (2.11 ppm) while the lowest Mn value was that of S-5/ Cantt Area Nowshera (0.05 ppm) and the rest of the samples have Mn values between these two limits 0.05-2.11ppm. Szefer and Palandysz (1984) measured the concentrations of Mn as 0.91-2.1 ppm in water of the Batlic States, which was similar to the present study. This revealed that both areas were affected due to the Manganese Oxide which is used in the hydrogenation of oil and other products. Manganese oxide and their sulfide are naturally occurring in rocks. During erosion these are mixed with the river water. Manganese is a health hazard if exceeded above the tolerance level. Through fish consumption, it enters into the human body, causing various diseases. The highest concentration of Cd was found at S-5 / Cantt Area Nowshera (1.46 ppm) while the lowest Cd value is that of S-1 / Warsak Area (0.42 ppm) and the rest of the samples have Cd values between these two limits 0.42-1.46 ppm.

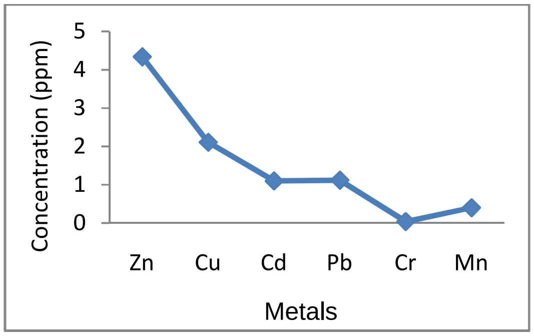

Fig. 2. Trace Metals Conc. at Site 1.

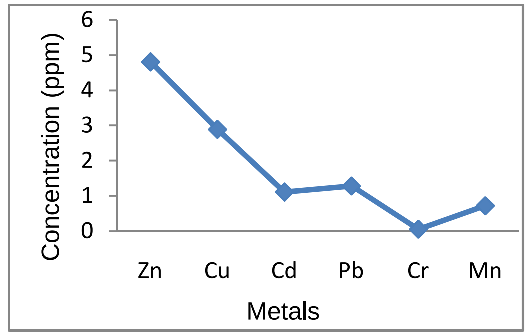

Fig. 3. Trace Metals Conc. at Site 2.

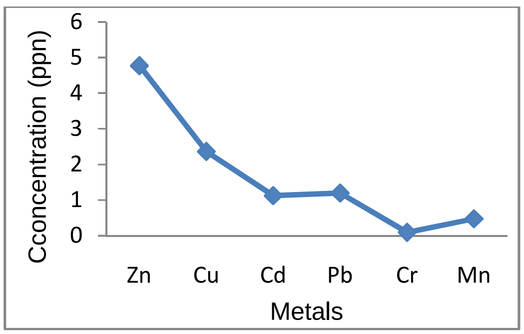

Fig. 4. Trace Metals Conc. at Site 3.

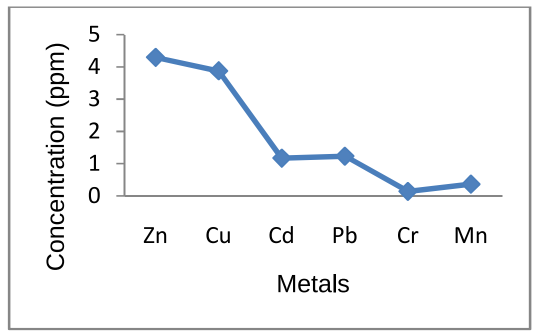

Fig. 5. Trace Metals Conc. at Site 4.

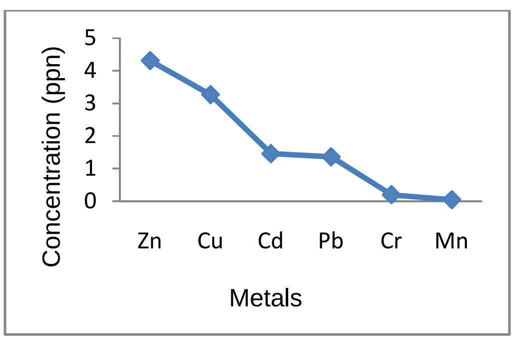

Fig. 6. Trace Metals Conc. at Site 5.

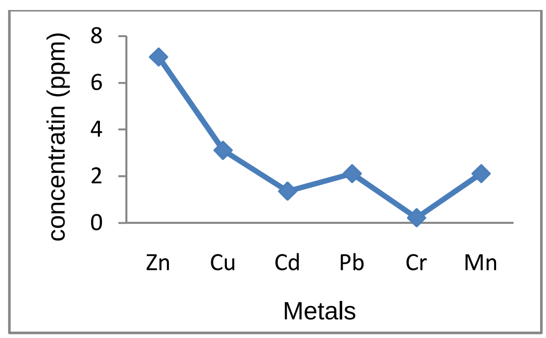

Fig. 7. Trace Metals Conc. at Site 6.

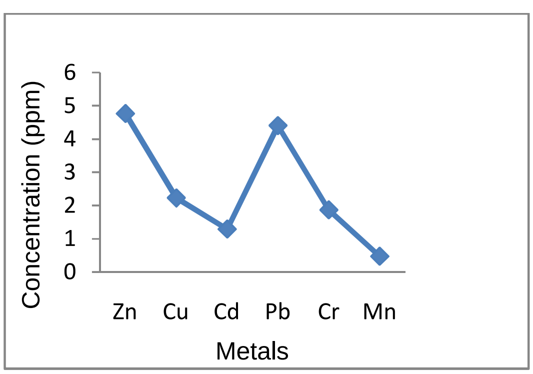

Fig. 8. Trace Metals Conc. at Site 7.

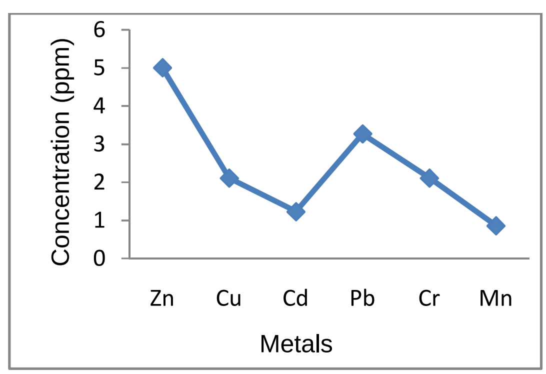

Fig. 9. Trace Metals Conc. at Site 8.

Jaleel *et al*. (1996) recorded Cd in river Kabul in the range of 0.01-0.022 mg/l, which was lower than the presently recorded levels. The highest value of Cd was due to the usage of cadmium oxide in the glass industries. The effluent is discharged to the River and the amount of Cd increases in water. Such water is unsuitable for drinking and irrigation. It also affects the fish respiratory system.

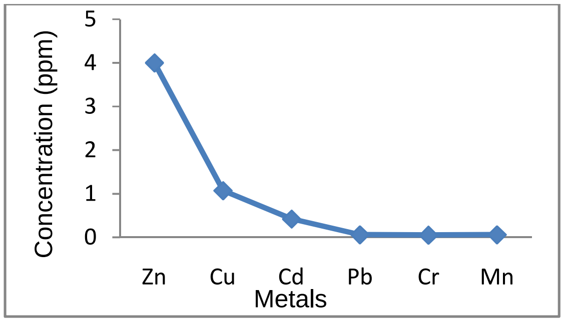

Fig. 10. Trace Metals Conc. at Site 9.

CONCLUSIONS

The overall results of the present study concluded that various kinds of anthropogenic activities including industrial effluents, civic wastes and various kinds of pollutants along the river Kabul have affected the water quality very badly at study area. This is quite evident from the high levels of heavy metals found beyond the suitable ranges and international permissible limits that if proper, timely remedial measures are not adopted, the situation will be aggravated and may cause many human health hazards, deterioration of the natural ecosystem of the river, huge mortalities of fish, etc.

ACKNOWLEDGEMENT

We are grateful to Pakistan Council of Scientific and Industrial Research for funding this study under HEC (2011-2012) program. Many thanks to Hameed Ur Rehman KUST; Gohar Ayaz (PhD Scholar), BZU Multan; Miss Sundus Zahid (Ph.D. Scholar) Department of Zoology; Wahid Raza (Ph.D. Scholar) Islamia College University Peshawar and all staff in PCSIR for their help during lab work. This study is a Part of my M. Phil thesis.

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