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Heavy metal analysis of water and soil of district Karak dams during fish breeding season, KPK, Pakistan

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Abstract
This study was conducted to determine the concentration of some heavy metals (Fe, Ni, Cu, Cr, Cd, Pb and Zn) in water and soil samples of four different dams located in the area of Karak, KPK, Pakistan. Water and soil samples collected from (Zebi dam, sarki dam, sharki dam and changos dam) were analyzed by inductively coupled plasma spectroscopy (ICP). The results obtained showed that the average value of Fe and Zn in both water and soil samples were found to be higher than other metals. Heavy metals analyzed in water and soil samples of all the four dam's indicated that among the seven heavy metals tested, Fe was maximum in concentration, followed by Zn, Cu, Pb, Ni, Cr and Cd. The sequence of heavy metals decreased in Zebi dam as Fe>Cu>Zn>Pb>Ni>Cr>Cd, in the sarki dam as Fe>Cu>Zn>Pb>Cd>Cr>Ni, in the sharki dam as Fe>Zn>Cu>Pb>Ni>Cd>Cr, and in the Changos dam as Fe>Zn>Pb>Cu>Cd>Cr> Ni respectively.

Keywords: Heavy metals, Zebi dam, sarki dam, sharki dam, changos dam

1. Introduction
Water is essential for life and is the most important single product in human civilization. Water is an amazing substance constantly moving from sea to land and back again. It shapes the earth's surface and moderates our climate. It is the medium in which all living process occurs. Water dissolves nutrients and distributes them to cells, regulates body temperature, supports structures, and removes waste products from the body [1, 2]. Rivers systems are being greatly polluted with heavy metals released from domestic wastes, industrial effluents, and agricultural runoff [3] Heavy metals are environmentally everywhere, readily dissolved in, transported by water, readily taken up by aquatic organisms and are considered to be persistent component in the aquatic environment. Fishes constitute major components of most aquatic habitats and they act as bio-indicator of heavy metal levels in aquatic environment [4, 5]. The fresh water ecosystem occupies a very small area in comparison to marine ecosystem. Now a day's fresh water resources degraded at large scale, due to water pollution. The effect of heavy metal on fresh water ecosystem has become global concern. The problem of water pollution by trace metal is known to be critical all over the world and especially in a developing country, where everybody is facing the problem of water pollution due to modern industrialization and civilization [6, 7].

Heavy metals are bio accumulated and bio transferred both by natural and anthropogenic sources. The contamination by heavy metals in water is one of the major issues to be faced throughout the world and requires attention because heavy metals above their normal ranges are extremely threatened to both plant and animal life. All heavy metals exist in surface waters in colloidal, particulate, and dissolved phases, although dissolved concentrations are generally low. The solubility of trace metals in surface waters is predominately controlled by the water pH, the type and level of ligands on which the metal could adsorb, and the oxidation state of the mineral components and the redox environment of the system [8, 9]. Heavy metal contamination may cause changes in the composition of the water and finally become inappropriate for human consumption [10]. The Industrial development in Pakistan from past few decades has launched many industrial zones at major Cities. These industries are producing tremendous amount of polluted products particularly heavy metals that are drained

into nearby rivers and enter continuously in the river untreated [11, 12]. The present study worked to investigate the pollutants levels including the accumulation of some heavy metals (Fe, Zn, Cu, Pb, Cr, Cd and Ni) in the soil and water samples of Zebi dam, Sarki dam, Sharki dam and Changos dam situated in Karak, KPK, Pakistan.

2. Materials and Methods

For the present investigation, water and soil samples were collected during breeding season of fishes from July, 2015- to March, 2016. The samples of water and soil were collected in clean plastic bottles of 1 liter volume from each station at the depth of one and half feet below the surface of water from sampling station-1 (Zebi dam) sampling station- 2 (Sarki dam), sampling station-3(Sharki dam) and sampling station 4 (Changos dam). Two samples (water and soil) were collected from each sampling site. The samples were then filtered through a membrane filter when necessary. The pH of all the water samples were noted immediately and water was acidified further. This acidified water was then brought into laboratory and stored at 4^0C until analysis. The heavy metals concentration was determined by using spectroscopic techniques [5, 8].

3. Result and Discussion

Heavy metal concentrations in water at different lakes are illustrated in table (1). Heavy metal concentration in water was found in the order: Fe>Zn>Pb>Cu>Cr>Cd>Ni in Zebi dam, follow the order of Fe>Cu>Pb>Zn>Cd>Cr>Ni in sarki dam, follow the order of Fe>Cu>Zn>Pb> and (Ni, Cd, Cr) were found undetected in sharki dam, whereas they follow the order of Fe>Zn>Pb>Cu>Cr>Cd> and (Ni, Cr) were not detected in the changos dam respectively. The overall order of metals in the four dams was as follow: Fe>Cu>Zn>Pb>Cd>Cr>Ni (Table 1).

Table 1: Heavy metals concentration (mg/L) in water of the Karak dams during breeding season of fish.

Dam		Fe	Cu	Zn	Pb	Ni	Cd	Cr	Total
Zebi	min	0.30	0.01	0.04	0.40	ND	ND	---	0.75
	max	34.17	1.43	2.65	1.92	ND	ND	0.05	40.22
Sarki	min	0.40	0.45	0.02	0.74	ND	0.01	0.02	1.64
	max	2.67	2.34	0.23	1.08	ND	0.10	0.08	6.5
Sharki	min	0.50	0.10	0.02	0.07	ND	ND	ND	0.69
	max	46.12	6.05	3.31	1.03	ND	ND	ND	56.51
Changos	min	0.55	0.30	0.01	0.01	ND	0.02	ND	0.89
	max	25.83	0.97	1.50	1.00	ND	0.23	ND	29.53
PL	1.00	1.00	1.00	0.05	0.2	0.01	0.01	0.02	3.29

PL: permissible limit according to USEPA and WHO. ND: not detectable

The difference among the four dams in metal content is in (Table 1). Maximum values of heavy metal were attained at Sharki dam. Zebi and Changos dam's ranked second and third in accumulation of metals, while sarki dam was found to be the less polluted one. This may due to higher number of plants and aquatic organism which absorb metals from water and soil. The maximum values of heavy metals (Fe, Cu and Zn) were recorded at Sharki dam as well as (Pb and Cr) at Zebi dam. Ni was found completely absent in the samples of water of all four dams. These levels are much higher than the permissible value [13]. This may be attributed due to huge amount of agriculture and industrial waste water discharged into the dams. The high value of metals in water can be attributed to agriculture and industrial discharge of waste material [14]. The higher levels of Pb in water samples of all the dams may be attributed due to combustion of petrol and gasoline in automobile car [15]. The maximum concentration of Zi in water of Sharki dam may be due to zinc leached from defense plates of boats which contains active zinc material [16].

3.1 Heavy metals in soil

The results from the soil samples of four dams are given in table (2). Heavy metal concentration in soil was found in the order: Fe>Cu>Zn>Pb>Ni>Cr>Cd in Zebi dam, follow the order of Fe>Zn>Cu>Pb>Ni>Cd>Cr in sarki dam, follow the order of Fe>Zn>Pb>Cu>Ni>Cd and Cr were found absent in sharki dam, whereas they follow the order of Fe>Zn>Pb>Cu>Cd>Ni and Cr were not detected in the changus dam respectively.

Table 2: Heavy metals concentration (mg/L) in soil of the Karak dams during breeding season of fish.

Dam		Fe	Cu	Zn	Pb	Ni	Cd	Cr	Total
Zebi	min	0.10	0.08	0.09	0.46	0.02	ND	ND	0.75
	max	39.96	4.67	3.14	2.98	0.41	ND	0.05	51.21
Sarki	min	0.10	0.30	0.46	0.23	0.07	0.02	ND	1.18
	max	39.20	5.15	6.47	4.06	0.62	0.09	ND	55.59
Sharki	min	0.20	0.20	0.02	0.49	0.06	ND	ND	0.97
	max	53.17	1.56	5.82	2.55	0.22	ND	ND	63.32
Changos	min	0.22	0.06	0.01	0.02	ND	0.01	ND	0.32
	max	31.20	0.61	3.64	0.98	ND	0.67	ND	37.10
PL	1.00	1.00	1.00	0.05	0.2	0.01	0.01	0.02	3.29

PL: permissible limit according to USEPA and WHO. ND: not detectable

The metal concentrations in soil varied widely and showed many differences in values of Fe, Cu, Zn, Pb and Cd. The order of concentrations of these metals in soil of four dams was as: Fe>Zn>Cu>Pb>Ni>Cd>Cr. Metals exhibited the same pattern of concentration as it was adopted by water. Iron attained highest value in sharki dam, while the lowest concentration was obtained in changes dam. The highest values of Zn, Cu, Pb and Ni were observed in sarki dam. On

the other hand, Cd and Cr reached its maximum value in changos and Zebi dam (for Cr). Iron is a fundamental element of blood and responsible for imparting red color to blood. High concentration of Iron causes bad taste, discoloration, staining, turbidity, esthetic and operational problems in water supply system [17]. High level of iron can harm plants, animals and cause health problems in humans [18]. Lead is a toxic heavy metal cause's anemia, brain damage and vomiting [19]. The high level of lead in soil could be attributed to the agriculture and industrial discharged as well as combustion of leaded petrol and some other types of gasoline [20].

By comparing the accumulation of heavy metals in soil and water, it can be concluded that the metals are highly accumulated in soil than water. Since the soil act as reservoir for all dead organic matter and contaminates the ecosystem.

4. Conclusion

Quantitative analysis of heavy metals was conducted for water and soil samples of four dams located in the regions of KPK, Pakistan. The studies reveal that different sampling sites have different concentrations of the metals. The concentration levels of certain heavy metals are alarmingly high in all the areas considered for sampling. Keeping in view the health risks involved due to the high levels of metals when they enter the human metabolism, measures should be taken to minimize these levels in the clean waters to lessen the imminent health risks.

5. References

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