

Accumulation of Heavy Metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plants and analysis of physico-chemical parameters of soil and water Collected from Tanda Dam kohat.

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Abstract

Heavy metals are bioaccumulated and biotransferred both by natural and anthropogenic sources. The contamination by heavy metals in plants and 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. It was therefore of interest to conduct study to estimate levels of heavy metals in plants, water and soil of Tanda dam kohat. Soil and water samples were also analyzed for physico-chemical parameters such as pH, hardness and electrical conductivity. Water samples were collected at random from the water reservoir of Tanda dam kohat. About 13 samples of water and 13 soil samples were collected at random and four wild plants namely *Xanthium strumarium*, *Acacia modesta*, *Dodmea viscosa* and *Tamarix aphyda* were collected from the same region. Heavy metals for which these samples were analyzed were cadmium, zinc, iron, copper, nickel, chromium and lead. Plants samples were analyzed separately for their root, stem and leaves. Flame absorption spectrometer was used for analyzing the samples. Results showed that concentrations of cadmium, chromium, iron and lead in water were recorded above the permissible limits set by WHO while zinc and copper were recorded below the permissible limits and no concentration of nickel was recorded in water samples. pH of all water samples was recorded below the normal range while hardness and electrical conductivity of all water samples were recorded above the normal range set by WHO. Concentrations of heavy metals in soil were also compared with WHO standards for heavy metals and in soil samples concentration of heavy metals were recorded above the permissible limits except zinc which was recorded below the permissible limits set by WHO. pH of all soil samples was recorded below the normal range while electrical conductivity of all soil samples was recorded above the normal range.

Keywords;

Soil, Water, Plants, pH, Conductancy, Heavymetals, Atomic, Absorption.

INTRODUCTION

Human activities such as industrial production, mining, agriculture and transportation, release high amounts of heavy metals into surface and ground water, soils and ultimately to the biosphere. Accumulation of heavy metals in crop plants is of great concern due to the probability of food contamination through the soil root interface. Though the heavy metal like, Cd, Pb and Ni are not essential for plant growth, they are readily taken up and accumulated by plants in toxic forms. Ingestion of vegetables irrigated with waste water and grown in soils contaminated with heavy metals possess a possible risk to human health and wildlife. Heavy metal concentration in the soil solution plays an important role in controlling metal bioavailability to plants. Most of the studies show that the use of waste water contaminated with heavy metals for irrigation over long period of time increases the heavy metal contents of soils above the permissible limit. Ultimately, increasing the heavy metal content in soil also increases the uptake of heavy metals by plants depending upon the soil type, plant growth stages and plant species [Abbas Ullah Jan et al 2011].

The most important sources of heavy metals in the environment are the anthropogenic activities such as mining, smelting procedures, steel and iron industry,

chemical industry, traffic, agriculture as well as domestic activities [L.Jantschi et al 2008, C, Stihl et al 2006]. Chemical and metallurgical industries are the most important sources of heavy metals in soils [A. Pantelica et al 2008, L. Jantschi et al 2008, V.G. Schutze et al 2007] The presence of heavy metals in soil can affect the wildlife, plant growth etc [Cojcaru et al 2006, I.V. Popescu et al 2009, A. Ene et al 2009].

These heavy metals may adversely affect soil ecology, agricultural production or product quality, and ground water quality, and will ultimately harm to health of living organism by food chain. These effects are closely related to the biological availability of heavy metals, which in turn are controlled by the metal ion speciation in the soil. Therefore, the determination of free metal ion concentrations in soil solution becomes important. The free metal ion concentration not only depends on the total metal content in soils, but also on the metal species that exist in the soil. In addition, some environmental conditions (e.g., pH, concentration of complexing ligands in solution, and the soil colloid). [A. Ene et al 2009]

Pollution of heavy metals in aquatic environment is a growing problem worldwide and currently it has reached an alarming rate. There are various sources of heavy metals; some originates from anthropogenic activities like draining

of sewerage, dumping of Hospital wastes and recreational activities. Conversely, metals also occur in small amounts naturally and may enter into aquatic system through leaching of rocks, airborne dust, forest fires and vegetation. As heavy metals cannot be degraded, they are continuously being deposited and incorporated in water, thus causing heavy metal pollution in water bodies. The presence of heavy metals in the water may have a profound effect on the microalgae which constitute the main food source for bivalve mollusks in all their growth stages, zooplankton (rotifers, copepods, and brine shrimps) and for larval stages of some crustacean and fish species. Moreover, bioconcentration and magnification could lead to high toxicity of these metals in organisms, even when the exposure level is low. Under such conditions, the toxicity of a moderately toxic metal could be enhanced by synergism and fish population may decline. Apart from destabilizing the ecosystem, the accumulation of these toxic metals in aquatic food web is a threat to public health and thus their potential long term impact on ecosystem integrity cannot be ignored [D.O.Ogoyi et al 2011].

Pollution of fresh water bodies, especially the rivers is no longer within safe limits for human consumption as well as aquatic fauna. This can be measured through the heavy metal analysis in fishes. Disposal of sewage wastes into a large volume of water could reduce the biological oxygen demand to such a great level that the entire oxygen may be removed. This would cause the death of all aerobic species including fishes. These may be derived from inputs of suspended solids to which toxic substances are absorbed; such as soil particles in surface water run-off from fields treated with pesticides. Pesticides are useful tools in agriculture but their contribution to the gradual degradation of the aquatic ecosystem cannot be ignored [Zigham Hassan et al 2012].

The Kohat Nala locally called as Kohat Toi originates from Hundo. During its flow it gets contaminated with agricultural, industrial and domestic wastes. Thus making it unfavorable for aquatic fauna especially fish and also affecting the water quality and making it hazardous for human household as well as drinking purposes. Its water is stored and this stored water is mostly used for irrigation purposes. Water of Tanda dam is used for irrigating the lands of Jarma and Dhoda shrif kohat. People using this water mostly suffer from different diseases like diseases of kidney, hair and gastrointestinal tract. For investigating these all, this study was done, to ultimate the industrialists, to ultimate the environmental protection agencies and to highlight the concerned authorities to take immediate precautionary steps for the betterment of environment, mankind and the aquatic life as well.

MATERIALS AND METHODS

Collection of samples

Sample collection was done randomly from the area of Tanda dam kohat. 13 water samples were collected at random from the water reservoir and were collected in plastic bottles. Four wild plants namely *Xanthium strumarium*, *Acacia modesta*, *Dodonaea viscosa* and *Tamarix aphyda*. These wild plants were collected in

polyethylene bags. Plants were selected randomly and some plant species that were collected were partially submerged in water. Plants were rooted out from the soil. Soil samples were collected from Tanda Dam region kohat and collection was done randomly. Samples were collected in two batches. Soil was taken from the shore line of water reservoir of Tanda Dam and also from locations near the water reservoir. Only 13 surface soils were collected and packed in polythene bags.

Sample treatment

Plants were separated into root leaves and stem and were oven dried at 110C. Soil samples were also oven dried at 110C. 2gram of each sample was acid digested using nitric acid. Samples were kept on hot plate. After removing from hot plate sample was filtered in 100 ml graduated cylinder up to 35 ml so that 35 ml of each sample was prepared. Water samples were directly subjected to analysis. Hardness of water samples was analyzed using flame photometer. Conductivity of water and soil samples was measured using conductivity meter while pH of water and soil samples was measured using pH meter.

Sample analysis

Samples of plants, soil and water were subjected to atomic absorption spectrometer (Perkin Elmer) for being analyzed for metals like Cd , Cr, Zn, Ni, Fe, Cu and Pb. The instrument setting and operational conditions were done in accordance with the manufacturers' specifications.

RESULTS AND DISCUSSION

Nickel (Ni): Nickel has been considered to be an essential trace element for human and animal health. [Zigham Hassan et al 2012]. The permissible limit of Nickel in plants recommended by WHO is 10mg/kg. The maximum permissible limit for Ni in water is 0.2 mg/l Concentration of [Zigham Hassan et al 2012] nickel in water samples ranged between 0.001 to 0.007mg/l which is below the permissible limit. In all the collected plant samples there was no concentration of nickel found. In the collected soil samples concentration of nickel ranged between 0.150 to 1.031mg/kg. In soil sample 11 and soil sample 12 concentration of nickel was recorded above the maximum permissible limit set by WHO.

Chromium (Cr): The permissible limit of Chromium for plants is 1.30mg/kg recommended by WHO. In plant *xanthium strumarium* concentration of chromium was below the permissible limit, in *Tamarix aphyda* concentration of chromium was above the permissible limit, in the root of *Dodonaea viscosa* concentration of chromium was above the permissible limit while in its leaves and stem concentration was below the permissible limit similarly in the leaves of *Acacia modesta* concentration was found above the permissible limit while in its stem and root concentration is below the permissible limit. The maximum permissible limit for Cr in water is 0.1 mg/l. The values of Cr in all water samples ranged between 1.313 to 2.886mg/l [Zigham Hassan et al 2012]. In all the collected water samples concentration of chromium was recorded above the permissible limit set by WHO. Concentration of chromium in soil samples ranged between 4.123 to 6.744mg/kg. In all the collected soil samples

concentration of chromium was recorded above the permissible limit set by WHO.

Cadmium (Cd): The permissible limit of Cadmium in plants, recommended by WHO, is 0.02 mg/kg. In the plant *Xanthium strumarium* concentration of cadmium was recorded above the permissible limit, in the leaves, stem and root of *Acacia modesta* concentration of cadmium was found above the permissible limit, in the stem, leaves and root of *Dodonae viscosa* concentration was above the permissible limit similarly in *Tamarix aphyda* concentration of cadmium was above the permissible limit. The maximum permissible limit for Cd in water is 0.01 mg/l. Concentration of cadmium in water samples ranged between 0.004 to 0.129mg/l (Table 1). In almost all the water samples concentration of cadmium was recorded above the permissible limit [Zigham Hassan et al 2012]. Concentration of cadmium in all the collected soil samples ranged between 0.029 to 0.328mg/kg. In all the collected soil samples concentration of cadmium was recorded above the maximum permissible limit set by WHO.

Copper (Cu): The permissible limit of copper for plants is 10mg/kg recommended by WHO [Zigham Hassan et al 2012]. In all the collected plant samples concentration of copper was recorded below the permissible limit. The maximum permissible limit for Cu in water is 2 mg/l in water samples concentration of copper ranged between 0.258 to 0.659mg/l. In all the collected water samples concentration of copper was recorded below the permissible limit. Contamination of drinking water with high level of copper may lead to chronic anemia [Asma Iqbal et al 2011]. Copper accumulates in liver and brain. Copper toxicity is a fundamental cause of Wilson’s disease [Samuel Zerabruk et al 2011]. Copper particulates are

released into the atmosphere by windblown dust; volcanic eruptions; and anthropogenic sources, primarily copper smelters and ore processing facilities. The fate of elemental copper in water is complex and influenced by pH, dissolved oxygen and the presence of oxidizing agents and chelating compounds or ions. Concentration of copper in all the soil samples was above the maximum permissible limit set by WHO. Concentration of copper ranged between 0.536-1.504mg/kg

Lead (Pb): The permissible limit in plants recommended by WHO is 2mg/kg. In the leaves of *Xanthium strumarium* concentration of lead was recorded below the permissible limit while in its root no lead was recorded, in the root of *Acacia modesta* concentration of lead was above the permissible limit while in its stem and leaves no lead was recorded, in the root, stem and leaves of *Dodonae viscosa* no concentration of lead was recorded, in the leaves of *Tamarix aphyda* concentration of lead was recorded below the permissible limit while in its root and stem no concentration of lead was recorded. According to WHO standards permissible limit of lead in water is 0.05mg/l and in all the collected water samples concentration of lead was above the permissible limit. Concentration of lead in all the collected water samples ranged between 0.167 to 0.723mg/l. Concentration of lead in soil samples was recorded to be ranged between 0.061 to 0.461mg/kg. In almost all the collected soil samples concentration of lead was recorded above the permissible limit set by WHO. Lead as a soil contaminant is a widespread issue; It accumulates with age in bones aorta, and kidney, liver and spleen. It can enter the human body through uptake of food (65%), water (20%) and air (15%).

Table 1. Heavy metal concentration (mg/l) in water samples, S.D (Standard deviation), N.D (Not detectable)

Water sample number	Mean conc of Cd in mg/L±S.D	Mean conc of Pb in mg/L±S.D	Mean conc of Ni in mg/L±S.D	Mean conc of Zn in mg/L±S.D	Mean conc of Fe in mg/L±S.D	Mean conc of Cr in mg/L±S.D	Mean conc of Cu in mg/L±S.D
Sample 1	0.014±0.014	0.321±0.160	0.006±0.397	0.229±0.00	1.772±0.087	1.313±0.141	0.561±0.077
Sample 2	0.004±0.029	0.499±0.269	0.005±0.117	0.226±0.004	2.028±0.265	1.956±0.204	0.542±0.083
Sample 3	0.091±0.007	0.181±0.595	0.002±0.461	0.228±0.004	1.885±0.115	1.683±0.632	0.596±0.076
Sample 4	0.117±0.034	0.336±0.188	0.007±0.191	0.228±0.001	1.966±0.290	2.227±0.174	0.459±0.114
Sample 5	0.129±0.087	0.723±0.243	0.001±0.370	0.226±0.005	1.988±0.149	2.175±0.087	0.659±0.097
Sample 6	0.145±0.065	0.581±0.685	0.006±0.328	0.221±0.004	2.122±0.417	2.886±0.328	0.616±0.039
Sample 7	0.050±0.023	0.342±0.64	0.005±0.43	0.233±0.008	2.143±0.12	2.354±0.16	0.281±0.053
Sample 8	0.085±0.116	0.322±0.43	0.004±0.07	0.256±0.007	2.443±0.132	2.565±0.13	0.271±0.011
Sample 9	0.097±0.086	0.334±0.34	0.003±0.432	0.233±0.006	1.745±0.13	1.993±0.16	0.264±0.024
Sample 10	0.085±0.045	0.412±0.61	0.007±0.44	0.244±0.005	1.982±0.2	2.192±0.15	0.258±0.018
Sample 11	0.060±0.145	0.167±0.56	0.003±0.654	0.233±0.005	2.343±0.31	1.899±0.14	0.280±0.018
Sample 12	0.010±0.043	0.176±0.56	0.005±0.76	0.211±0.009	1.982±0.21	2.432±0.13	0.289±0.005
Sample 13	0.165±0.061	0.167±0.45	0.002±0.45	0.231±0.004	1.711±0.31	1.912±0.16	0.549±0.207

Table 2. Heavy metal concentration (mg/kg) in the leaves and root of *Xanthium strumarium*, S.D (Standard deviation), N.D (Not detectable)

<i>Xanthium strumarium</i>	Mean conc of Cd in mg/kg±S.D	Mean conc of Pb in mg/kg±S.D	Mean conc of Ni in mg/kg±S.D	Mean conc of Zn in mg/kg±S.D	Mean conc of Fe in mg/kg±S.D	Mean conc of Cr in mg/kg±S.D	Mean conc of Cu in mg/kg±S.D
Leaves	0.27±0.00	1.205±0.00	N.D	0.101±0.031	108±0.302	0.696±0.00	0.791±0.052
Root	0.063±0.00	N.D	N.D	N.D	2.645±0.087	0.263±0.00	0.804±0.040

Table 3. Heavy metal concentration (mg/kg) in the leaves, root and stem of *Acacia modesta*, S.D (Standard deviation), N.D (Not detectable)

<i>Acacia modesta</i>	Mean conc of Cd in mg/kg±S.D	Mean conc of Pb in mg/kg±S.D	Mean conc of Ni in mg/kg±S.D	Mean conc of Zn in mg/kg±S.D	Mean conc of Fe in mg/kg±S.D	Mean conc of Cr in mg/kg±S.D	Mean conc of Cu in mg/kg±S.D
Leaves	0.170±0.032	N.D	N.D	0.091±4.66	19.36±1.147	2.466±0.235	0.66±0.079
Stem	0.135±0.031	N.D	N.D	N.D	3.04±0.104	0.379±0.204	0.744±0.058
Root	0.162±0.013	4.710±0.18	N.D	N.D	6.878±0.423	0.858±0.130	0.709±0.52

Table 4. Heavy metal concentration (mg/kg) in the leaves, root and stem of *Dodonaea viscosa*, S.D (Standard deviation), N.D (Not detectable)

<i>Dodonaea viscosa</i>	Mean conc of Cd in mg/kg±S.D	Mean conc of Pb in mg/kg±S.D	Mean conc of Ni in mg/kg±S.D	Mean conc of Zn in mg/kg±S.D	Mean conc of Fe in mg/kg±S.D	Mean conc of Cr in mg/kg±S.D	Mean conc of Cu in mg/kg±S.D
Leaves	0.207±0.028	N.D	N.D	0.182±0.006	17.22±0.918	0.563±0.175	2.597±0.030
Stem	0.352±0.035	N.D	N.D	0.086±0.004	3.325±0.004	0.858±0.398	0.848±0.045
Root	0.328±0.037	N.D	N.D	N.D	8.969±0.258	1.503±0.235	0.634±0.016

Table 5. Heavy metal concentration (mg/kg) in the leaves, root and stem of *Tamarix aphyda*, S.D (Standard deviation), N.D (Not detectable)

<i>Tamarix aphyda</i>	Mean conc of Cd in mg/kg±S.D	Mean conc of Pb in mg/kg±S.D	Mean conc of Ni in mg/kg±S.D	Mean conc of Zn in mg/kg±S.D	Mean conc of Fe in mg/kg±S.D	Mean conc of Cr in mg/kg±S.D	Mean conc of Cu in mg/kg±S.D
Leaves	0.162±0.013	0.617±0.595	N.D	0.151±0.012	19.43±0.711	1.575±0.204	0.707±0.096
Stem	0.207±0.048	N.D	N.D	N.D	7.952±1.322	1.337±0.130	0.626±0.043
Root	0.352±0.035	N.D	N.D	N.D	7.490±0.302	1.495±0.197	0.528±0.029

Table 6. Heavy metal concentration (mg/kg) in soil samples, S.D (Standard deviation), N.D (Not detectable)

Soil sample number	Mean conc of Cd in mg/kg ±S.D	Mean conc of Pb in mg/kg ±S.D	Mean conc of Ni in mg/kg ±S.D	Mean conc of Zn in mg/kg ±S.D	Mean conc of Fe in mg/kg ±S.D	Mean conc of Cr in mg/kg ±S.D	Mean conc of Cu in mg/kg ±S.D
Sample 1	0.287±0.051	0.061±0.061	N.D	0.222±0.031	143.1±151.4	4.309±0.822	0.607±0.025
Sample 2	0.268±0.053	0.09±0.285	N.D	0.349±0.11	208.2±33.59	4.934±0.322	0.603±0.020
Sample 3	0.259±0.024	N.D	N.D	0.213±0.012	313.5±5.144	4.561±0.692	1.504±0.047
Sample 4	0.279±0.030	0.461±0.417	N.D	N.D	159.6±39.89	5.929±0.390	0.878±0.068
Sample 5	0.319±0.042	0.259±0.659	N.D	0.033±0.003	258±37.95	6.774±0.082	0.927±0.068
Sample 6	0.019±0.09	0.243±0.654	0.150±0.040	0.231±0.001	143.4±32.12	4.623±0.081	0.717±0.016
Sample 7	0.108±0.455	0.211±0.632	N.D	0.211±0.006	207.1±34.32	4.231±0.832	0.563±0.018
Sample 8	0.029±0.163	0.134±0.621	0.502±0.134	0.312±0.042	200.1±6.87	5.231±0.088	0.779±0.009
Sample 9	0.077±0.131	0.132±0.643	0.086±0.056	0.223±0.03	142.2±33.65	4.212±0.712	0.824±0.048
Sample 10	0.059±0.117	0.114±0.564	N.D	0.122±0.02	156.2±3.43	5.213±0.421	0.536±0.014
Sample 11	0.328±0.328	0.412±0.654	1.031±0.138	0.221±0.01	145.2±32.33	4.991±0.441	0.937±0.036
Sample 12	0.135±0.048	0.231±0.643	0.684±0.089	0.212±0.04	159.2±33.32	4.123±0.212	0.798±0.0120
Sample 13	0.082±0.109	0.241±0.543	0.302±0.0105	0.201±0.05	144.2±31.2	5.112±0.654	0.768±0.010

Iron (Fe): Iron in drinking water is present as Fe²⁺ or Fe³⁺ in suspended form. It causes staining in clothes and imparts a bitter taste. It comes into water from natural geological sources, industrial wastes, domestic discharge and also from by products. Excess amount of iron (more than 10 mg/kg) causes rapid increase in pulse rate and coagulation of blood in blood vessels, hypertension and drowsiness. The maximum allowed concentration of iron in drinking water is 1.0 mg/L according to WHO report [Gutam Patel et al 2011]. In all the collected water samples concentration of iron was recorded above the permissible limit according to WHO. Concentration of iron in water samples ranged between 1.745 to 2.443mg/l. The WHO recommended level of iron in plants is 20 mg/kg [Afzal Shah et al 2011]. In the leaves of *Xanthium strumarium* concentration of iron was recorded above the permissible

limit while in all the other collected plants its concentration was recorded below the permissible limit. Concentration of iron in all the collected soil samples ranged between 143.1 to 313.5mg/kg. In all the soil samples concentration of iron was above the permissible limit set by WHO.

Zinc (Zn): Zinc is one of the important trace elements that play a vital role in the physiological and metabolic process of many organisms. Nevertheless, higher concentrations of zinc can be toxic to the organism. It plays an important role in protein synthesis and is a metal which shows fairly low concentration in surface water due to its restricted mobility from the place of rock weathering or from the natural sources. Concentration of zinc in water samples ranged between 0.211 to 0.256mg/l. The permissible limit of zinc in water according to WHO standards is 5mg/l. In all the

collected water samples concentration of zinc was recorded below the permissible limit. WHO’s recommended limit of zinc in plants is 50 mg/kg[Afzal Shah et al 2011].In most of the collected plants no concentration of zinc was recorded while in some it was recorded below the permissible limit. Concentration of zinc in soil samples ranged between 0.033 to 0.349mg/kg. In all the soil samples concentration of zinc was recorded below the permissible limit set by WHO.

Physio-chemical parameters of water and soil

Physical parameters include temperature and color of water while chemical parameters include pH, dissolved oxygen contents, alkalinity, hardness and electrical conductivity. In this experiment only chemical parameters such as electrical conductivity, pH and hardness were measured. Table 8 shows the results for pH, electrical conductivity and hardness of collected water samples. WHO normal ranges for pH are 6.5-8.5. pH of all the collected water samples was recorded within the normal range. WHO normal range for electrical conductivity of water is 400-600 µS/cm. In all the collected water samples values of electrical conductivity were recorded above the normal range. WHO normal range for hardness of water is 50-250mg/ml.[Zigham Hassan et al 2012]

Table 7.Physico-chemical parameters of water samples

Water sample number	Conductivity(µS/cm)	pH	Hardness(ppm)
Sample 1	1166	7.84	280
Sample 2	1212	8.15	310
Sample 3	1313	7.79	270
Sample 4	1489	8.28	290
Sample 5	1172	8.20	311
Sample 6	1234	8.32	345
Sample 7	1030	7.32	270
Sample 8	1243	7.64	315
Sample 9	1168	7.61	345
Sample 10	1172	7.45	350
Sample 11	1065	7.45	298
Sample 12	1148	7.46	340
Sample 13	1168	7.22	312

In all the collected water samples hardness was recorded above the normal range. Similarly in all the collected soil samples pH was recorded within the normal range set by WHO while electrical conductivity was recorded above the permissible limits for electrical conductivity set by WHO. All these parameters have their own importance as they are part of environment necessary for conductance of life processes. For example pH is a measure of acid-base equilibrium achieved by water dissolved compounds as well as extent of flocculation and coagulation process of chemicals. Similarly electrical conductivity gives an idea about the concentration of electrolytes in water and is the limiting factor. Electrical conductivity (EC) which is a measure of water’s ability to conduct an electric current is related to the amount of dissolved minerals in water, but it does not give an indication of which element is present but higher value of EC is a good indicator of the presence of

contaminants such as sodium, potassium, chloride or sulphate while hardness of water is defined as the measure of concentration of dissolved calcium and magnesium ions in water. Hardness of water is very important property of water and is very important for life processes. Analysis of all these parameters is very necessary because their knowledge is very important for fish and human health.

Table 8.Physico-chemical parameters of soil samples

Soil sample number	pH	Conductivity(µS/cm)
Sample 1	7.12	545
Sample 2	7.44	599
Sample 3	7.86	674
Sample 4	6.93	589
Sample 5	7.35	690
Sample 6	7.64	740
Sample 7	7.64	750
Sample 8	7.05	780
Sample 9	7.58	745
Sample 10	8.34	756
Sample 11	6.36	780
Sample 12	7.54	760
Sample 13	7.84	745

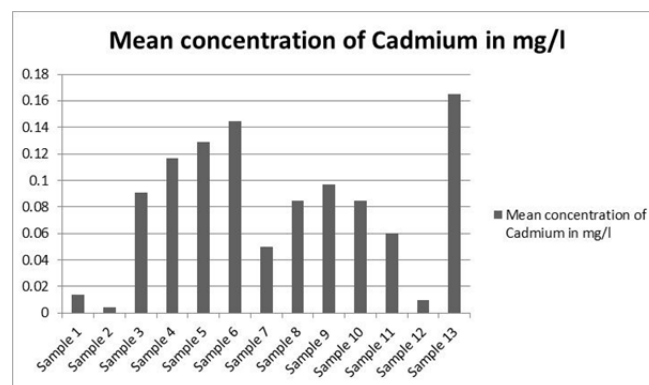


Figure 1: Mean concentration of Cadmium in water samples

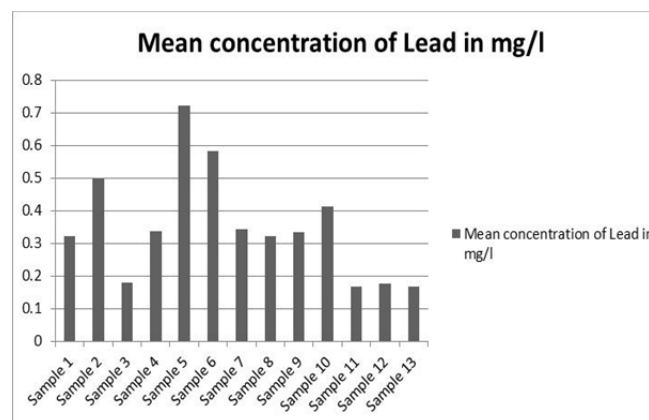


Figure 2: Mean concentration of Lead in water samples

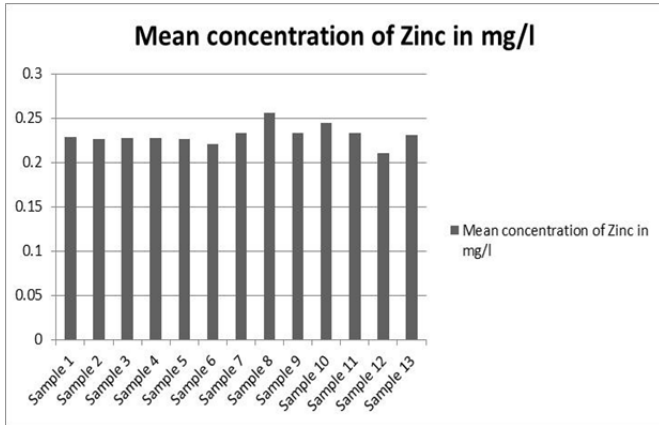


Figure 3: Mean concentration of Zinc in water samples

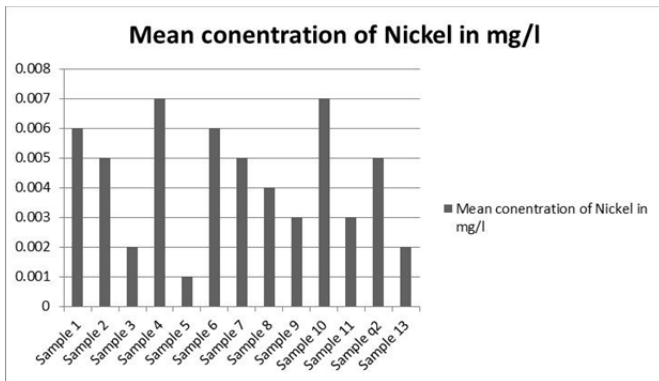


Figure 4: Mean concentration of Nickel in water samples

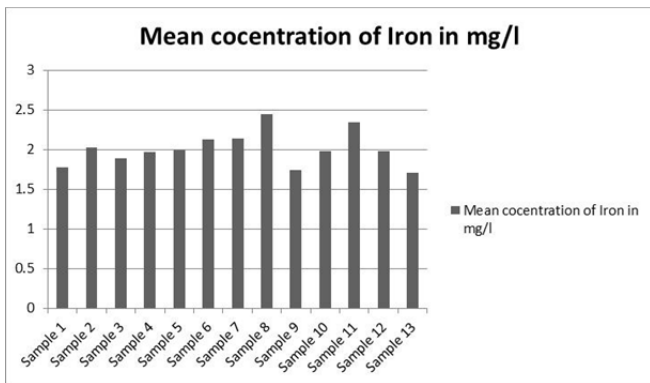


Figure 5: Mean concentration of Iron in water samples

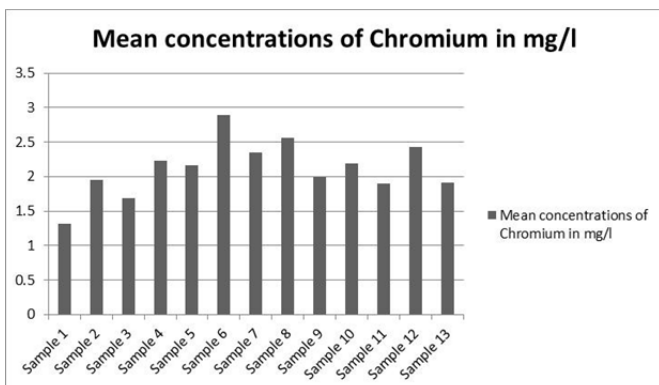


Figure 6: Mean concentration of Chromium in water samples

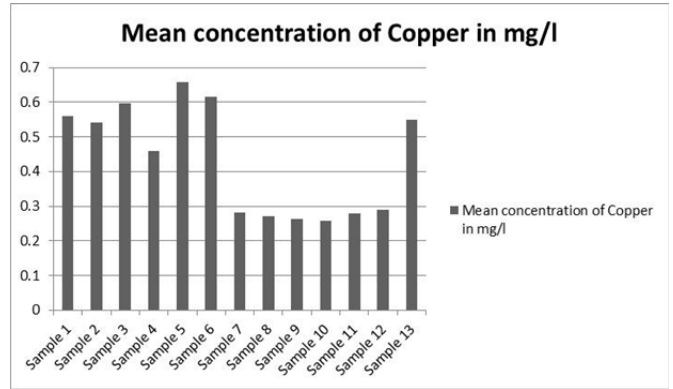


Figure 7: Mean concentration of Copper in water samples

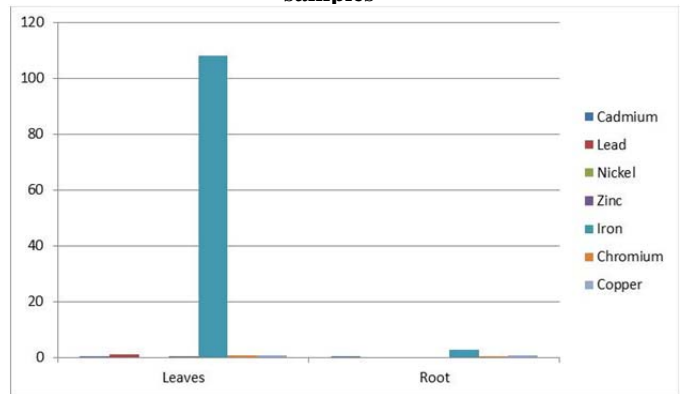


Figure 8: Mean concentration of heavy metals in mg/kg in *Xanthium strumarium*

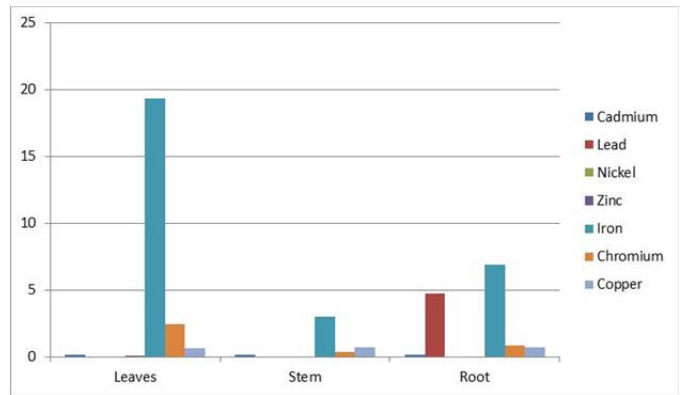


Figure 9: Mean concentration of heavy metals in mg/kg in *Acacia modesta*

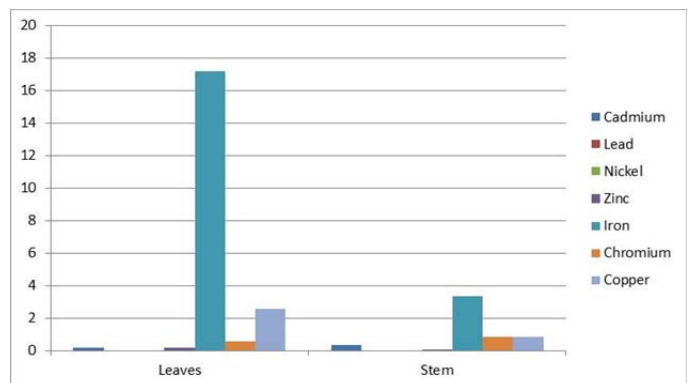


Figure 10: Mean concentration of heavy metals in mg/kg in *Dodonaea viscosa*

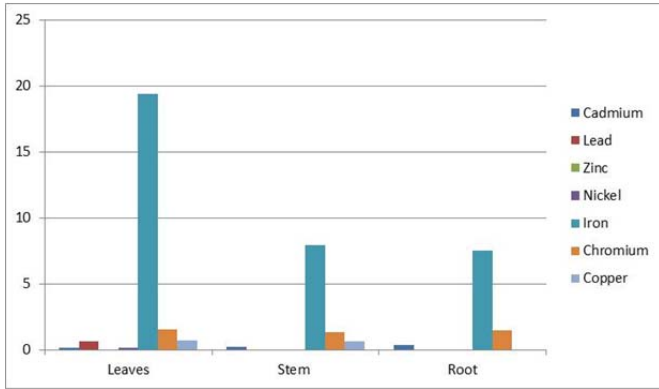


Figure 11: Mean concentration of heavy metals in mg/kg in *Tamarix aphyda*

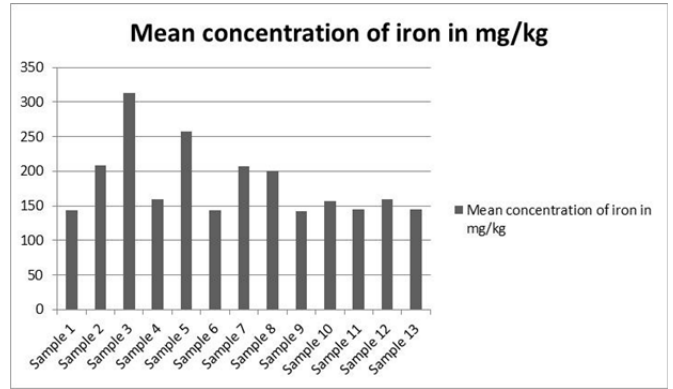


Figure 15: Concentration of Iron in soil samples

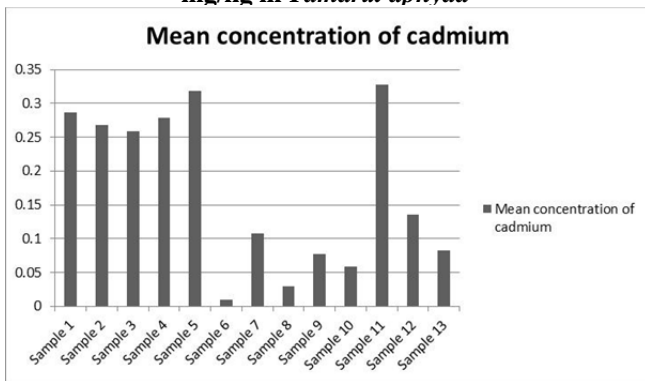


Figure 12: Concentration of Cadmium in soil samples

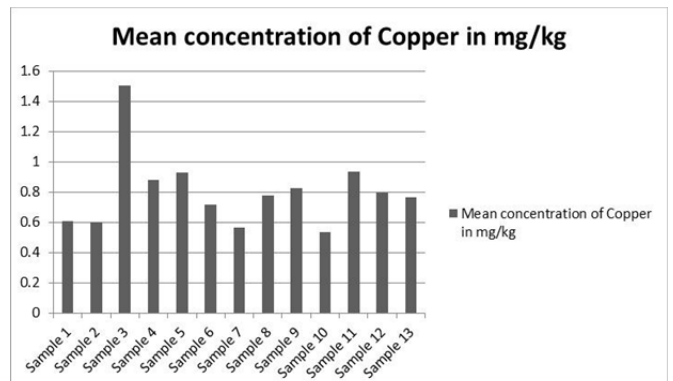


Figure 16: Concentration of Copper in soil samples

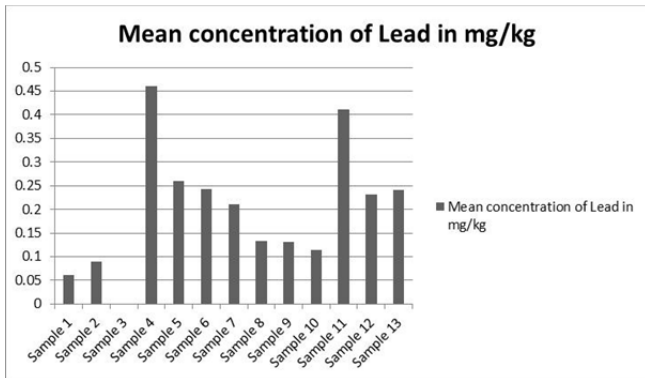


Figure 13: Concentration of Lead in soil samples

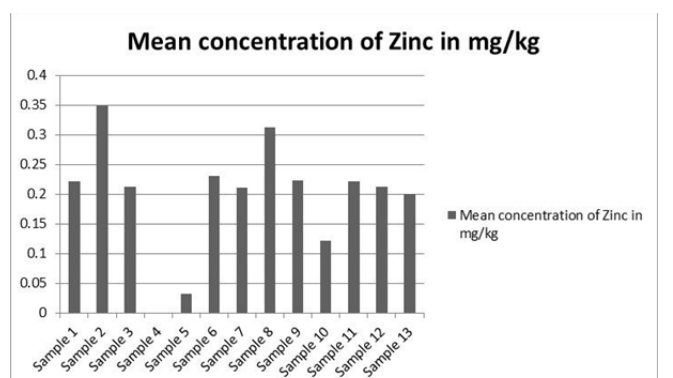


Figure 17: Concentration of Zinc in soil samples

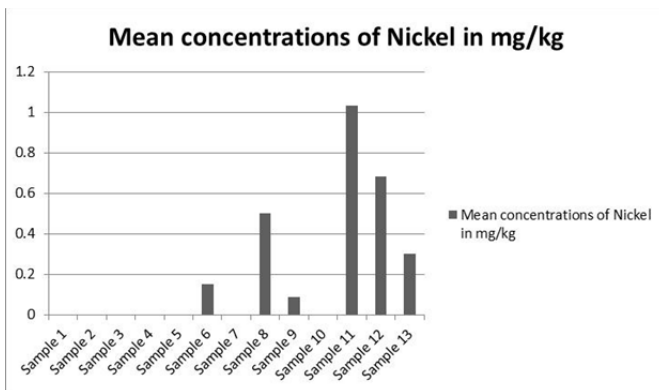


Figure 14: Concentration of Nickel in soil samples

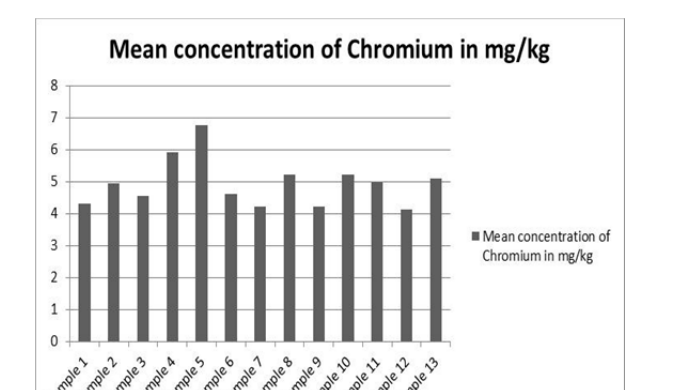


Figure 18: Concentration of Chromium in soil samples

DISCUSSION

Present study was conducted in order to assess the heavy metal contamination of water, soil and plants of Tanda dam District Kohat KPK. As water pollution is dangerous for both aquatic and human health so it is the need of hour to assess the water quality of rivers and dams as this is a very important issue related to human and environment. For this purpose 13 water samples were collected from the surface of water reservoir and also four wild plants including *Xanthium strumarium*, *Acacia modesta*, *Dodonaea viscosa* and *Tamarix aphylla* were collected from Tanda dam Kohat. 13 soil samples were also collected from the surface and also from the shoreline of Tanda dam kohat. Water and soil samples were subjected to heavy metal analysis and also for chemical parameters including pH, electrical conductivity and hardness while plants were only analyzed for heavy metals. Results were presented in the form of tables.

When water samples were collected and analyzed for heavy metals (Zn, Cu, Fe, Cd, Cr, Ni and Pb) it was found that the concentrations of heavy metals i.e. cadmium, chromium, iron and lead were beyond the maximum permissible limits set by WHO. The study revealed the heavy metal content in the water of Tanda dam Kohat is beyond the normal range and is extremely dangerous for human consumption. Analysis of chemical parameters of water concluded that pH of water is within the normal range set by WHO while electrical conductivity and hardness of water were recorded above the normal range set by WHO. Similarly in all soil samples concentration of all heavy metals was recorded above the permissible limits set by WHO except zinc which was recorded below the permissible limits. pH of all soil samples was recorded below the normal range while electrical conductivity of all soil samples was recorded above the normal range. In *Tamarix aphylla*, root of *Dodonaea viscosa* and leaves of *Acacia modesta* concentration of chromium was found above the normal range. Similarly cadmium was found above the permissible limits in *Acacia modesta*, *Xanthium strumarium*, *Tamarix aphylla* while in the leaves of *Dodonaea viscosa* its concentration was above the permissible limit. Concentration of lead was above the permissible limits in the root of *Acacia modesta*. In the leaves of *Xanthium strumarium* concentration of iron was recorded above the permissible limits. While rest of the metals were recorded below the permissible limits in all the collected plant samples.

The reason for this extremity in values is might be due to the addition of civic wastes and industrial effluents as the sewage of the city is directly discharged into the river along with the industries which are also discharging their effluents directly into the river. This is in agreement with the studies (Zaigham Hassan *et al.*, 2012) who reported that the level of heavy metals increasing in the rivers due to discharge of industrial effluents and civic pollution of various kinds. This is in turn deteriorating the water quality making it unsuitable for both aquatic and human life.

CONCLUSIONS AND RECOMMENDATIONS

The main goal of this research work was to assess the concentration of some toxic heavy metals and also some chemical parameters such as pH, electrical conductivity and hardness of water and collected from Tanda dam Kohat. Also some collected wild plants were analyzed for heavy metals. A total of 13 water samples were collected and were analyzed for three chemical parameters (EC, pH and hardness) and seven heavy metals (Zn, Fe, Cr, Cd, Pb, Cu and Ni) similarly 13 soil samples were also analyzed for heavy metals and two chemical parameters (pH and EC) while four wild plants were also analyzed for seven heavy metals (Zn, Fe, Cr, Cd, Pb, Cu and Ni) using standard procedures. The results show that pH of all the water samples was within the permissible limits set by WHO, whereas the values of electrical conductivity of all the collected water samples were found to be extremely higher than permissible limits set by WHO similarly hardness of collected water samples was also recorded to be higher than WHO permissible limits. pH of soil samples was also recorded within the normal range but EC was recorded above the permissible limits set by WHO. Concentration of selected heavy metals was also recorded in the selected wild plants.

RECOMMENDATIONS

1. People should not be allowed to dispose their civic waste in the water of Toi river kohat.
2. Research work should be carried out to study the accumulation of heavy metals in the crops which are irrigated by the water of Tanda dam kohat.
3. Research work should be carried out to study the effects of heavy metals on the people of kohat especially on the people of Dhoda sharif, Tanda and Jarma whose agricultural lands are irrigated by the water of Tanda dam kohat.
4. Agricultural waste should not be disposed in the water of Toi river kohat and for this purpose awareness should be developed in the people.
5. Government should pay attention to improve water quality of Tanda dam kohat which should also consider heavy metals. So that soil is be exposed to minimum amount of heavy metals.

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