IMPACTS OF JAMSHORO THERMAL POWER STATION ON SOIL OF THE SURROUNDING AREA

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ABSTRACT
Thermal power stations apart being source of energy supply are causing soil pollution leading to its defertilization and contamination. The environmental evaluation of surrounding soil of thermal power station Jamshoro in Pakistan will serve as a model study to get the insight into hazards it is causing. The metal composition of soil was studied with focus on Cu, Pb, Zn, Ni, Cr and Fe in soil samples were collected around the power station at the depth of 9 and 18 inches respectively. Perkin Elmer 800 Atomic Absorption Spectrophotometer was used for the determination of metals.

Key Words: Soil Pollution, Thermal Power Plant and Trace Toxic Elements

INTRODUCTION
Environmental pollution is a major issue of world; different kind of pollutants enters into the environment affecting it adversely. Water, soil and air pollution are serious issues of Pakistan today. Industrial sector is one of the point source of pollution in addition them thermal power stations are effecting the environmental. Soil is the main source of trace and toxic elements for plants both as micronutrients and pollutants (Zhenli et al., 2005). However some exceptions can be found in situations of heavy atmospheric deposition of pollutants (Torunn et al., 1997 and Eiliv Steinnes et al., 1994) or from flooding by contaminated waters. The origin of trace and toxic elements influences their behavior in soils and therefore controls to some extent their bioavailability (Laing et al., 2009).
The chemistry of the soil solution provides useful information on soil processes that are important to agricultural and environmental sciences. Therefore, data on concentrations of trace and toxic elements in a "real" soil solution can be useful for the prediction of their availability, toxic effects on crops and on the biological activities in soils. The partitioning of trace and toxic elements between the soil solid phase and the soil solution determines their mobility and bioavailability (McBride & Murray, 1997).
Contamination of soil with cadmium (Cd), nickel (Ni), copper (Cu), lead (Pb), arsenic (As), chromium (Cr), tin (Sn) and zinc (Zn) can be a primary route of human exposure to these potentially toxic elements (Moir &Thornton, 1989; Reilly, 1991; Lehoczky et al., 1998 and DEFRA & EA, 2002). Trace metals may enter the human body *via* inhalation of dust, consumption of contaminated drinking water or ingestion of soil or crops grown on contaminated land (Cambra et al., 1999 and Dudka & Miller, 1999). The seepage of contaminated water into the soil affects the soil fertility as well as causes the food contamination. Plants growing in the contaminated soil become the source of contaminated food for humans and animals. When these plants are used as food source by humans and animals affect their biological life in several ways.
The present study was carried out Jamshoro Thermal Power station, which is located on the main Indus highway running from Jamshoro to Dadu at 250 28' N and 680 16' E. It is approximately 5 km in the north from Jamshoro, Sindh Pakistan. The Thermal Power Station of Jamshoro also playing a vital role supplying electricity for country but current study shows its effluents are affecting surrounding soil adversely.
Water source of TPS is Indus River; 1500000 to 1800000 liter/day of water is used for cooling purpose in thermal power station, while water used for residential purpose is about 60000-liter/h. The water after the using in turbines is released in to opened channel, which flows from thermal power station to river Indus. This water highly contaminated with various trace and toxic elements, which damage surrounding agricultural soil area. Moreover, in urban agriculture, wastewater and solid organic wastes are often the principal sources of irrigation and fertilizer used to enhance the yields of staple crops and vegetables (Urie, 1986; Feigin et al., 1991 and Qadir et al., 2000). Municipal or industrial effluent and solid waste are often rich in trace metals and contribute significantly to metal loadings in irrigated and waste-amended urban soils (Nyamangara & Mzezewa, 1999; Nan et al., 2002 and Singh et al., 2004).
Our country depends on agricultural land, and the protection of good soil is very important (Ludwig Beck et al., 2005). In Sindh province it is estimated that 62% land of Sindh is arid which is uncultivated and it is estimated that only 41% of the land of Sindh is cultivated (Millennium development goal report 2010). In this field different crops

are grown including Rice which is 32% of total rice production of the country, Sugarcane which is 24% of the total sugarcane production of the country, cotton 12% and wheat 12% of the total production of the country.
This study was taken for the determination of soil contaminants which coming from the waste water of thermal power station and making suggestion to conserve and preserve the soil fertility and taking steps for protect the soil.

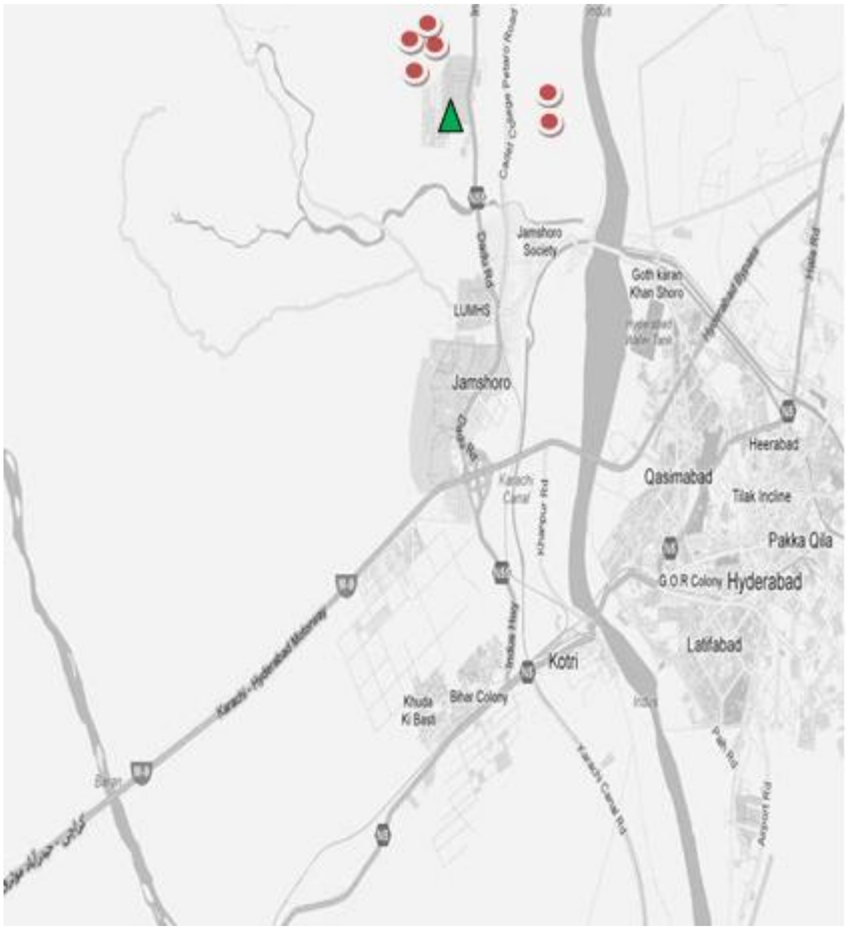

Figure 1: Map showing sampling area

Sampling Site--------------------- Jamshoro Power Station-------

MATERIALS AND METHODS

Chemicals and reagents

All chemicals and reagents used for the investigation were of high purity and they were analytical grade. Hexane (96+ %), acetone (99%), ethyl acetate (99.8%), anhydrous sulphate ere purchased from Sigma-Aldrich, Germany. The PCBs standards were supplied by United Nation Environmental Program (UNEP).

Sample collection

For the determination of required trace heavy elements in soil, samples were collected around the power station at the different locations at the depth of 9 and 18 inches respectively (R.K. Rattan *et al* 2005). Set of first sample was collected from near northwest of TPS (25º 25.202´N, 68º 15.677´E) where Bersem crops are cultivated. Second Set sample was collected from northwest of TPS (25º 28.202´N, 68º 15.617´E) where cotton crops were grown. Third sample was collected from near road from TPS (25º 28.077´N, 68º 17.98´E) to Indus; land was ready for bowing the crops. In this way for current study six samples were collected in polythene bags and labeled carefully.

Sample preparation

These samples were brought in laboratory and leaved for drying in air. After the complete drying of the samples Solution was prepared for the determination of trace elements Cu, Pb, Zn, Ni, Cr, Fe , (Davies & Houghton, 1984; Albasel & Cottenie, 1985; Burguera et al., 1988; Bacon et al., 1992 and Kelly et al., 1996) in soil samples. A weighed quantity 0.50 g of soil sample was taken in teflon beaker (LI Wei-Xin et al., 2008) and 5 ml of hydrofluoric acid HF was added to it for leaching of metals from sample to solution. After 15 minutes 5 ml of HNO_3 was added to it to leach nitric acid soluble metals and then it was again heated on hot plate till completely dried. After this 50 ml 2N HCL was added to the beaker to complete the leaching process. The beaker was heated on low flame for a short time until the residue was almost dissolved. The sample solution was then stored in contaminant free test tube and properly capped. This solution was then aspired in atomic absorption spectrophotometer (Daniela Salvagio Manta et al., 2002) for the determination of trace elements.

RESULTS AND DISCUSSION

Trace elements enter an ecosystem through both natural and anthropogenic processes. Soil inherits trace elements from its parent materials. Some soils have been found to have a high background of some trace elements which are toxic to plants and wild life due to extremely high concentrations of these elements in the parent materials.

Accumulation of trace elements, especially heavy metals, in the soil has potential to restrict the soil's normal function causing toxicity to plants and contaminate the food chain. In recent years, it has also been found that heavy metals from point and non-point sources impair water systems.

Current study shows that soil is contaminated due to effluents of power station and may be due to the acidic deposition on soil due to emission of smoke from the chimneys of thermal power station (Fernindez-Sanjurjo et al., 1998). The serious health concern for human is that they depend on crops growing on this contaminated soil.

In this study area the copper was found between 0.7mg/g up to 9.5 mg/g in soil, According to National Environmental Quality Standards of Pakistan (NEQS) allowable limit of copper in soil is 1.0 mg/g. Copper does not break down in environment. Source of copper may be use of copper material in power house including construction equipments and electrical equipments. On the other hand fuel in combustion chambers of power station also may be a large source of copper in surrounding area.

When excessive copper ends up in soil it accumulate there and causes contamination in crops which when eaten by consumers it magnify in the body of consumers and causes irritation of abdomen and intestine, headaches, dizziness, vomiting and even death. Higher than normal Cu supplies usually inhibit root growth more than shoot growth.

Current study shows that soil samples are highly contaminated by copper as shown in fig. 2. Comparison of concentration of copper in sample with National Environmental Quality Standard is plotted in fig. 2.

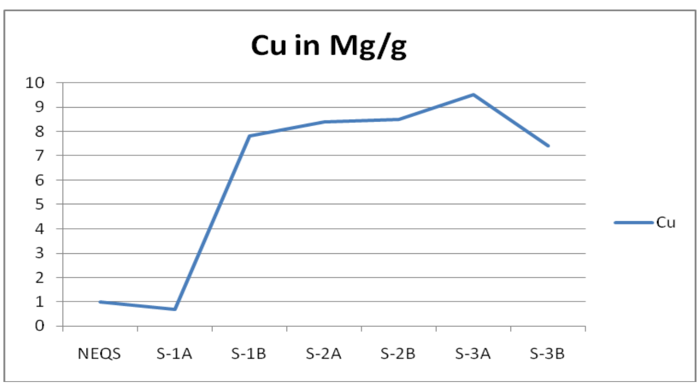

Figure 2: **Comparison of concentration of copper in sample with NEQS**

Iron is believed to be the tenth most abundant element in the universe. Iron is also the most abundant (by mass, 34.6%) element making up the earth. The concentration of iron in the various layers of the earth ranges from high at the inner core to and its about 5% in the outer crust. Most of this iron is found in form of iron oxides, such as the minerals hematite, magnetite, and taconite. The earth's core is believed to consist largely of a metallic iron-nickel alloy.

The Iron may cause conjunctivitis, choroiditis, and retinitis if it contacts and remains in the tissues. Chronic inhalation of excessive concentrations of iron oxide fumes or dusts may result in development of a benign pneumoconiosis, called siderosis, which is observable as an x-ray change. No physical impairment of lung function has been associated with siderosis. Inhalation of excessive concentrations of iron oxide may enhance the risk of lung cancer development in workers exposed to pulmonary carcinogens.

Iron in Study area was found in access amount, the iron range is study area was between 11 mg/g up to 23 mg/g whereas NEQS for iron is 02.0 mg/g. study shows that soil of area contains high concentration of iron which causes major health problems. It mostly affects infants and pregnant women (Kayode et al., 2006). The combined direct and indirect effects of iron contamination decrease the species diversity (Vuori, 1995). The Fig. 3 shows concentration of iron in soil and its comparison with NEQS.

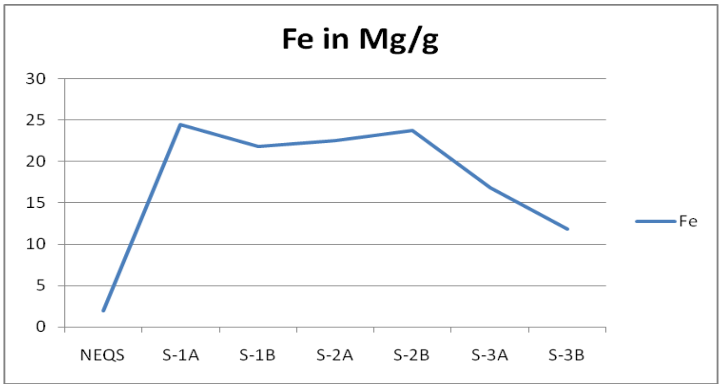

Figure 3: **Comparison of concentration of iron in sample with NEQS**

Chromium is found naturally in rocks, soil, plants, and animals, including people. It occurs in combination with other elements as chromium salts, some of which are soluble in water. The pure metallic form rarely occurs naturally. Chromium does not evaporate, but it can be present in air as particles. Because it is an element the chromium does not degrade nor can it be destroyed.
The extensive use of chromium in metallurgy, leather tanning, electroplating, lumber, power generation and other industries has led to its release into the subsurface environment. When it is in excess (NEQS 1 mg/g) it can cause allergic reactions, such as skin rash. health problems that are caused by chromium are Skin rashes, Upset stomachs and ulcers, Respiratory problems, Weakened immune systems, Kidney and liver damage, Alteration of genetic material, Lung cancer, Death.
Chromium in study area was found from 0.2 to 0.3 mg/g, this shoes that the level of chromium is under limits according NEQS. Graphic representation of chromium is given in Fig. 4.

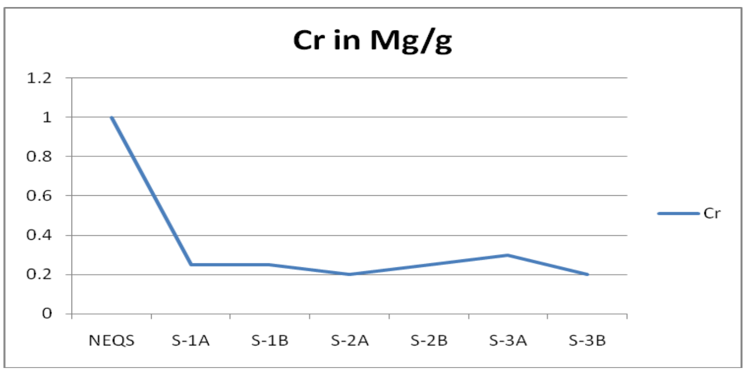

Figure 4: **Comparison of concentration of chromium in sample with NEQS**

Zinc in study area was found from 0.7 mg/g up to 6.7 mg/g. excess amount of Zinc was found in sample 2B up to 6.79mg/g. It was collected from northwest of power station. Zinc is a trace element that is essential for human health. When people absorb too little zinc they can experience a loss of appetite, decreased sense of taste and smell, slow wound healing and skin sores. Zinc-shortages can even cause birth defects. Zinc also had a strong effect on the size of the microbial communities. Although humans can handle proportionally large concentrations of zinc, too much zinc can still cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anemia.
In some samples level of zinc was very low; zinc deficiency is a particularly widespread micronutrient deficiency in wheat, leading to severe depressions in wheat production and nutritional quality of grains (Graham et al., 1992; Graham & Welch, 1996). As in soils and plants, Zn deficiency is also a common nutritional problem in humans, predominantly in developing countries where diets are rich in cereal-based foods and poor in animal protein (Prasad,

1984). In Turkey, Zn deficiency is the most widespread micronutrient deficiency in soils and plants. Based on analysis of 1511 soil samples collected from all provinces of Turkey, (Eyüpoglu et al., 1994) showed that 50% of the cultivated soils in Turkey are Zn deficient.

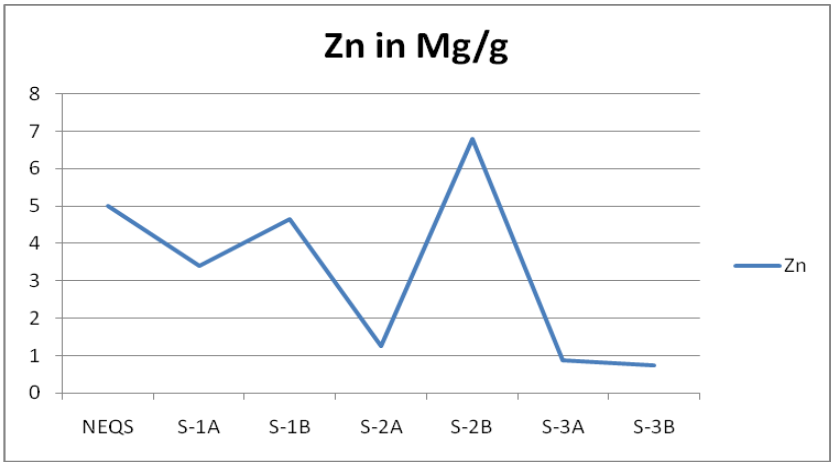

Figure 5: Comparison of concentration of zinc in sample with NEQS

During our study lead was found up to 0.05 mg/g in soil, which is under standard level of NEQS which is 0.5 mg/g. Iron deficiency and lead poisoning are common among infants and children in many parts of the world, and often these two problems are associated. Both conditions are known to cause anemia and appear to produce a more severe form of anemia when in combination. Although the nature of their relationship is not completely elucidated, the characterization of a common iron–lead transporter and epidemiological studies among children strongly suggest that iron deficiency may increase susceptibility to lead poisoning. Recent human studies suggest that high iron intake and sufficient iron stores may reduce the risk of lead poisoning. The level of iron in study area is maximums that may be the cause of low level of lead in study area. The fig. 6 represents the concentration of lead in soil of study area.

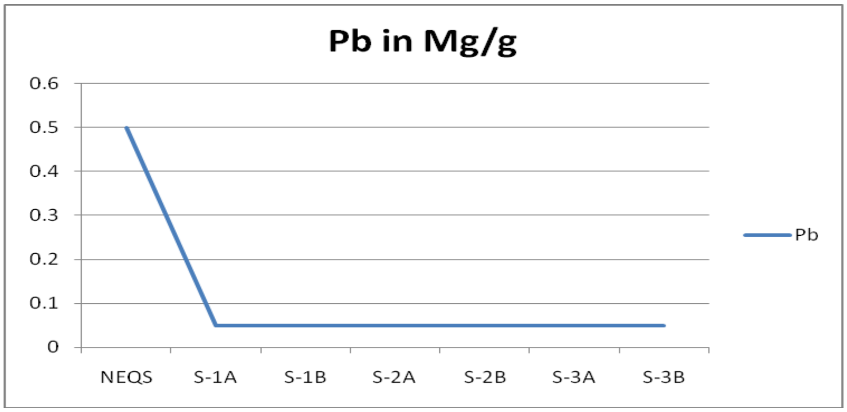

Figure 6: Comparison of concentration of lead in sample with NEQS

Table 1: **Trace elements is soil Mg/g**

Sample No.	Ni	Fe	Cr	Cu	Zn	Pb
NEQS	1.00	02.0	1.00	1.0	5.0	0.50
S-1A	0.17	24.5	0.25	0.7	3.4	0.05
S-1B	0.15	21.9	0.25	7.8	4.65	0.05
S-2A	0.06	22.6	0.20	8.4	1.25	0.05
S-2B	0.15	23.8	0.25	8.5	6.79	0.05
S-3A	0.14	16.9	0.30	9.5	0.86	0.05
S-3B	0.18	11.9	0.20	7.4	0.73	0.05

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Ni Concentration of Soil was up to 0.18 mg/g. it is also bellow the standard limit of NEQS which is 1 mg/g. Under Ni-deficient conditions, barley plants fail to produce viable grain because of a disruption of the maternal plant's Ni should be considered a micronutrient for cereals. Because Ni is required by legumes, and is now established as essential for cereals. Therefore we conclude that Ni should be added to the list of micronutrients essential for all higher plant growth (Brown et al., 1987).

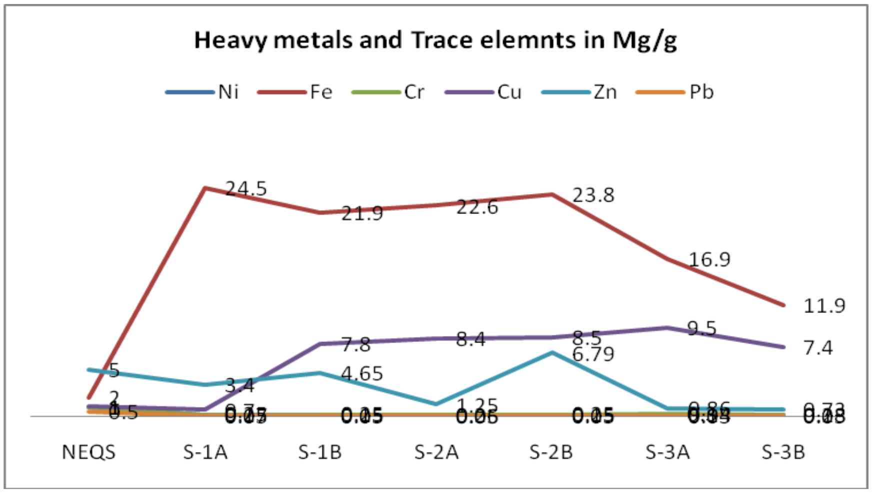

Figure 7: The graphical representation of tabulated data gives the glimpse of composition of the soil under study

Heavy metals are extremely persistent in the environment; they are non biodegradable and non thermo degradable and thus readily accumulate to toxic levels. Heavy metals can accumulate in the soil at toxic levels due to the long-term application of wastewater (Bohn et al., 1985).

CONCLUSION

The current study shows that thermal power station contaminates the surrounding soil with toxic elements like chromium, iron and zinc through its effluents. Therefore soil fertility is completely destroyed and some crops tolerating contaminated soil take up the toxic elements and pose serious health hazards for consumers. The vital soil organisms are also destroyed due to these contaminations affecting natural ecology.

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