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Assessment of Pb, Zn, Cu, Ni, Cr and Co in the Soils of Badin area, Sindh, Pakistan

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Abstract: This study was conducted to determine Pb, Zn, Cu, Ni, Cr and Co in the soils of district Badin, Sindh, Pakistan. Badin is located near coastal area of Sindh province. Left Bank Outfall Drain (LBOD), Kadhan Pateji Outfall Drain (KPOD) and the Dhoro Puran Outfall Drain (DPOD) elevates storm-runoff, agricultural excessive water, industrial and municipal effluents to the Arabian Sea passing through area. Due to natural disasters such as cyclones and floods the LBOD has inundated this area many times which has caused adverse effects on the chemistry of soils. For the assessment of heavy and trace metals such as Pb, Zn, Cu, Ni, Cr and Co, representative soil samples were collected from different parts of the study area and were analyzed. The results were compared with international standards. The data indicates that the concentration of Pb is 12 to 37 mg/kg^{-1}, Zn 61 to 615 mg/kg^{-1}, Ni 23 to 64 mg/kg^{-1}, Cr 29 to 69 mg/kg^{-1} and Co 23 to 49 mg/kg^{-1} in the studied soil samples. The data further indicate that the current results are above the permissible limits proposed for the environmentally safe agricultural soils. However, Cu contents are found within the acceptable limit in majority of the samples except village Haji Hajjam, Ali Bangali, Qasim Mallah, Guni, and Ahmed Rajo. It is, therefore, recommended that the appropriate measures should be taken for the proper management and remediation of the soils of Badin district.

Keywords: Badin, Soil, Heavy metals, Trace elements

1. INTRODUCTION

The study area is situated near coastal belt of Pakistan. Left Bank Outfall Drain (LBOD), Kadhan Pateji Outfall Drain (KPOD) and the Dhoro Puran Outfall Drain (DPOD) was constructed to elevate storm-runoff, agricultural excessive water, industrial and municipal effluents to the Arabian Sea through Tidal Link canal coursing from this area **(Fig. 1).** LBOD, KPOD, DPOD and its network drains water has inundated this area many times and in the result the soils and groundwater of the area are badly affected. Further, after the functioning of LBOD system, cyclone A2 in 1999 hit the area. Due to that, the drainage system was damaged severely while Tidal Link canal "the important part" of the drainage system was totally destroyed and is beyond to repair.

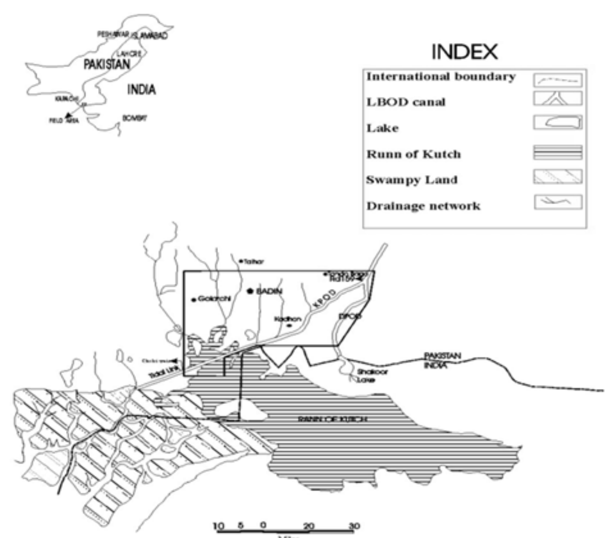

Fig. 1 location map LBOD, KPOD, DPOD and Tidal Link canal

Soil pollution due to metals is increasing day by day with urbanization and industrialization (Kumar, 2006). Along with natural sources, combustion of fossil fuels, the industrial and urban sewage sludge, the repeated use of metal-enriched chemicals, fertilizers, and organic amendments are generally considered as the major sources for the contamination of soils (Adriano, 1986; He *et al.,* 2005; Vandecasteele and Block, 1997). Though the lithological change is also responsible to increase or decrease the level of heavy and trace metal in the soil but it occurs on small scale whereas human activities are large contributors and has caused severe environmental issues in the world. Although human impact on the biosphere has been traced back since Neolithic Period while it has caused ecological degradation significantly in the past few decades (Kabata-Pendias, 2004).

Due to the disposal of waste effluents, the level of trace elements increases in both soils and waters. The

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accumulation of trace elements in soils for long time periods can damage the environment of living organisms; it can also cause health effects to human. Therefore, it is imperative to monitor the input, mobility and effects of trace elements in order to develop remediation plans (McGrath *et al.,* 2008; Sabudak *et al.,* 2007).

Soil is a most important component of geo-sphere it has significant effects on eco-biodiversity (Sastre *et al.,* 2002). If trace elements level increases above the permissible limits it may cause toxic effects to plants, animals and human health. Soil plays a vital role in controlling transport of contamination to underneath the surface (Kabata-Pendias, 2004) and is linked hydrologically to groundwater systems. Therefore, it is very essential to identify and understand the nature, level and source of occurrence of pollutants. If the soil is contaminated it can contaminate the groundwater also (Environment, 2006.) This study evaluates the level and distribution of Pb, Zn, Cu, Ni, Cr and Co in the soils of district Badin, Sindh, Pakistan.

2. MATERIALS AND METHODS

Sample Collection: To determine Pb, Zn, Cu, Ni, Cr and Co in the soils of Badin, 23 representative soil samples were collected from the selected locations. For each location two samples were taken at the depth of 45cm and a diameter of 3cm. The profile arrangements of these samples were as: i. Sample A at a depth of 0 to 22.5cm (A horizon), ii. Sample B at a depth of 22.5 to 45cm (B horizon). **(Fig. 2)** shows the location of soil samples collected during field. Each sample was given a code, hereinafter each sample will be referred with its particular code: 1A; 1B =Haji Hajjam, 2A; 2B = Ali Bengali, 3A; 3B = A. R. Jat, 4A; 4B = Natho Lund at left side of KPOD, 5A; 5B = Qasim Mallah, 6A; 6B = Guni, 7A; 7B = Ahmed Rajo, 8A; 8B = lake Narahri, 9A; 9B = Near tower, 10A; 10B = Tando Bago, 11A; 11B = Dewan sugar mill Khoski, 12A; 12B = Jhangi near LBOD spine, 13A; 13B = Near DPOD after weir about 400m, 14A; 14B = Pangrio, 15A; 15B = Pangrio-Khoski road, 16A; 16B = M. Bachal, 17A; 17B = Tarai, 18A; 18B = Achar Samejo, 19A; 19B = Juna, 20A; 20B = leghari oil field, 21A; 21B = Bawani sugar mills, 22A; 22B = Lawari sharif, 23A; 23B = Army sugar mills. After the collection of samples, all the samples were properly labeled and transferred to polythene bags and transferred to laboratory for the analysis of above elements.

Sample preparation and analysis: The soil samples collected from different localities of study area were air dried for 24 hours and then were dried at 110ºC. After that, samples were pulverized ina Tungsten Carbide Ring Mill. After every run, the mortal

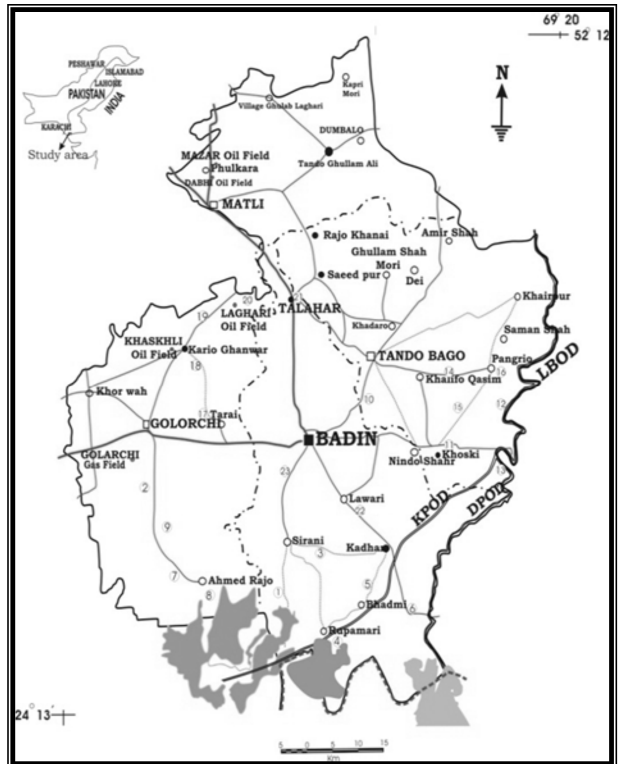

Fig. 2 Map showing the location of soil samples collected in the study area

was cleaned anddried in order to avoid the possibility of contamination. Finally the solutions were prepared from the powder.For solution preparation to determination Pb, Zn, Cu, Ni, Cr, Co; HF and HNO_3 method was used. The solution was then aspirated in atomic absorption for the determination above elements. Working standard solution of 50, 100, and 200 µg/l were also prepared for above elements. Prepared solution of soil samples were run after the calibration of the atomic absorption. The entire analytical results of Pb, Zn, Cu, Ni, Cr and Co were obtained by using Perkin Elmer Atomic Absorption Spectrophotometer.

3. RESULTS AND DISCUSSION

Different authors and agencies have recommended some standards for normal agricultural soil for example (Adriano, 1986; Berrow and Reaves, 1984; Bohn *et al.,* 2001; Chen *et al.,* 1999). But in current study we follow the standards suggested by Bohn *et al.* (2001). All the studied heavy and trace metals are described one by one in following section.

Lead (Pb): It is present naturally in soils and waters in trace amount. Burning of fossil fuels, smelting, traffic, waste incineration and agricultural application of sewage have caused its increase level in soil and water (Holmgren *et al.,* 1993; Moges *et al.,* 2013; Nazir *et al.,* 2015; Wong *et al.,* 2002). The acceptable limit of Pb for normal agricultural soil is 10 mg/kg^{-1}(Bohn *et al.,* 2001). Lead contents in different soils of the study area are found in the range between 12 to 28 mg/kg^{-1} in A horizon and 21 to 37 mg/kg^{-1} in B horizon **(Fig. 3).** All the soil samples show high contents of Pb then that of the recommended value by Bohn *et al.* (2001).

Zinc (Zn): It is one of the essential elements which play a very important role in physiological and metabolic process of plants and animals. However, its high concentration can be toxic to the organisms. The acceptable limit of Zn in normal agricultural soils is 50 mg/kg^{-1}(Bohn *et al.,* 2001). **(Fig. 4)** shows the concentration of Zn in the soils of study area. The concentration of zinc in all soil samples is ranging between 61 to 615 mg/kg^{-1} in horizon A and 56 to 534 mg/kg^{-1} in horizon B. All the soil samples show high concentration of Zn then that of the normal agricultural soil recommended by Bohn *et al.* (2001).

Copper (Cu): The average content of Cu in world's soils is 30 mg/kg^{-1}. Bohn *et al.* (2001) suggested that Cu contents level should be 20 mg/kg^{-1} in normal agriculture soils. The high concentration of copper is due to over utilization of copper containing materials such as fertilizers, spray, and agriculture, municipal and industrial wastes. **(Fig. 5)** presents the level of Cu contents in different soil samples of the study area. Perceived data show that most of soil samples are in the range of 6 to 20 mg/kg^{-1}, in both A and B horizons. However, samples No. 1A, 2A, 5A, 6A, 7A, 8A, 10A, 1B, 2B, 5B, 6B, 7B, 8B, 10B, 16B, 18B, 20B, 22B and 23B collected from village Haji Hajjam, village Ali Bengali, village Qasim Mallah, Guni near road, village Ahmed Rajo, Near lake Narahri, Tando Bago road, village M. Bachal, village Tarai, village Achar Samejo, and Lawari sharif respectively showed higher contents of Cu than that of the normal agricultural soil of Bohn *et al.* (2001).

Nickel (Ni): The recommended level for normal agricultural soils is 40 mg/kg^{-1} (Bohn *et al.,* 2001). Fig.5 shows Ni concentration in different soil samples of study area. Ni concentration in all the samples is found in the between of 36 to 64 mg/kg^{-1} in horizon A and 23 to 59 mg/kg^{-1} in horizon B **(Fig. 6).** It is clear from figure 6 that majority of the samples have high contents of Ni than that of the normal agricultural soil recommended by Bohan *et al.* (2001).

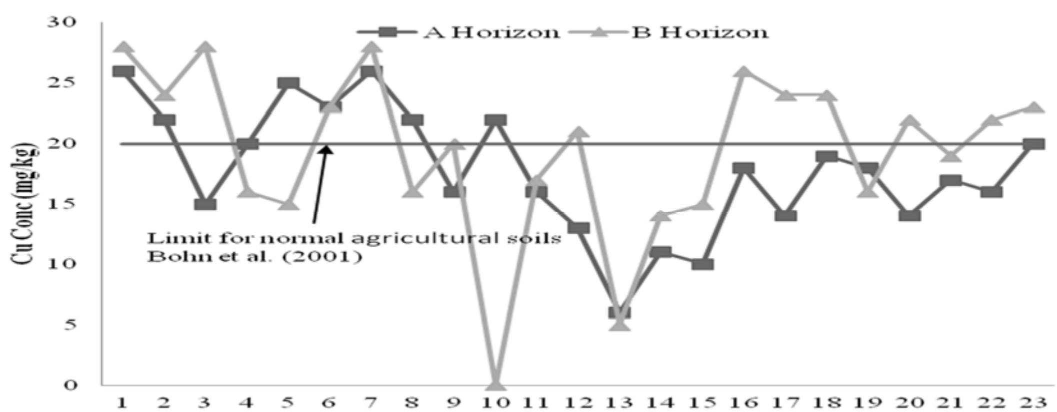

Fig. 3 Lead concentrations in soil samples at various locations in Badin

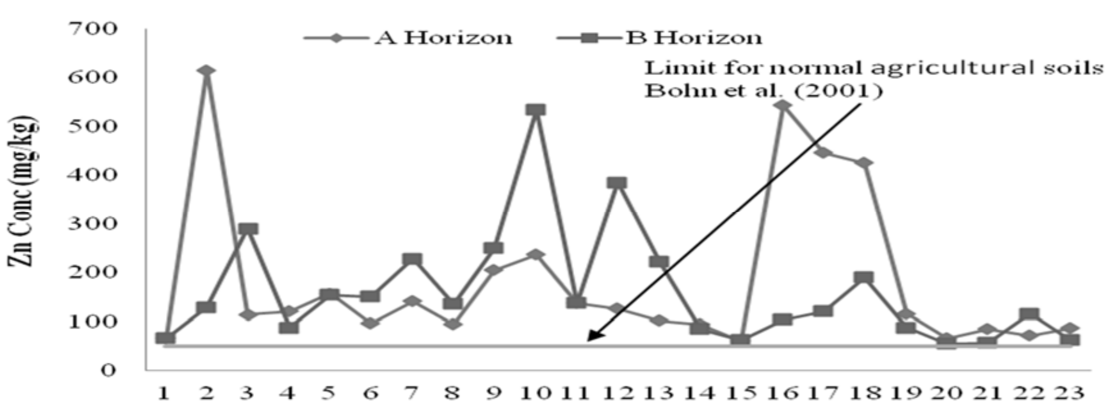

Fig. 4 Zinc concentrations in the soil samples from various localities of Badin

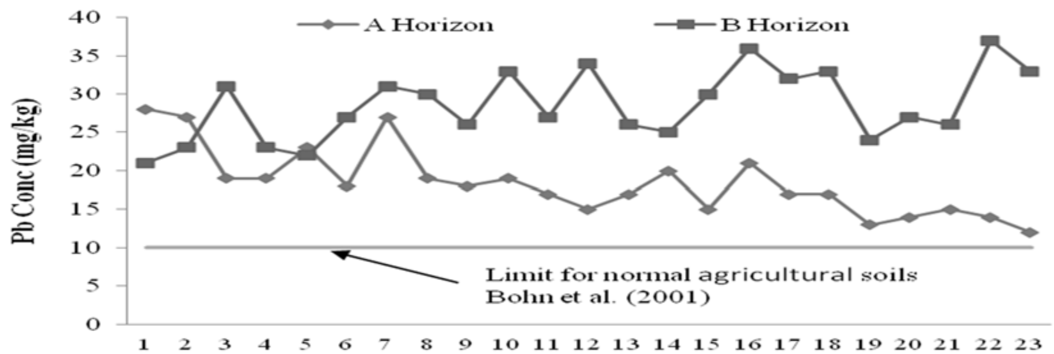

Fig. 5. Cu concentrations in the soil samples from various localities of Badin

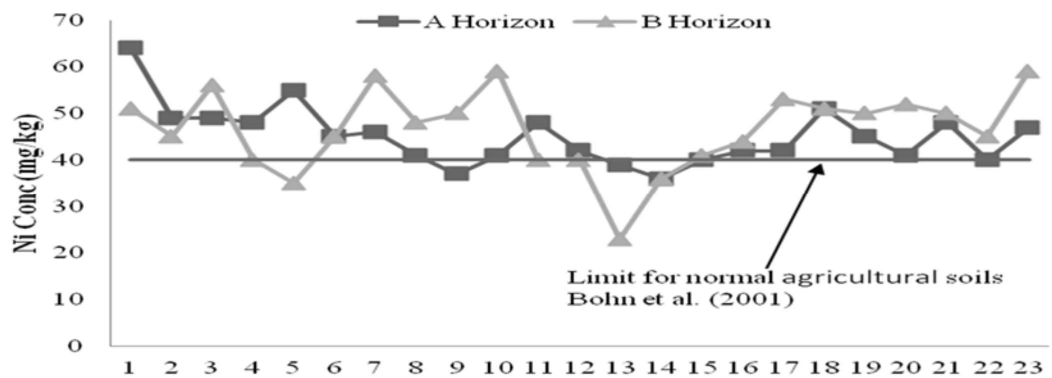

Fig.6. Nickel concentrations in the soil samples atvarious localities of Badin

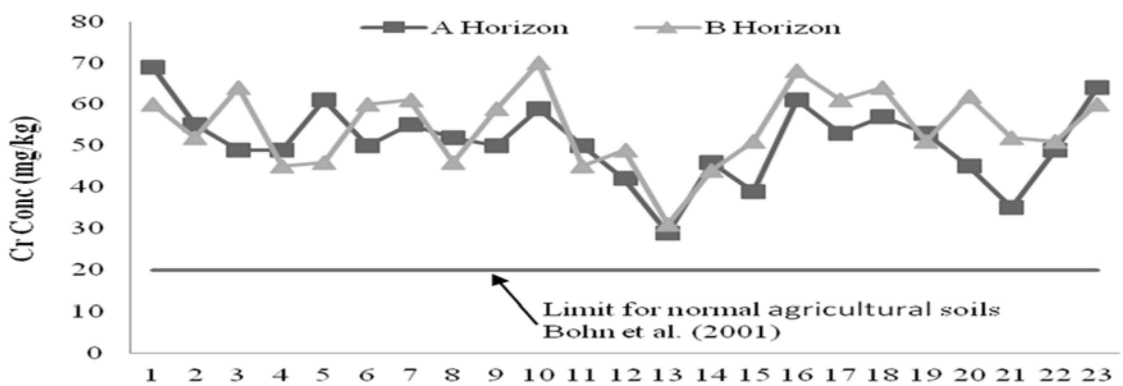

Fig. 7 Cr concentrations in the soil samples from various localities of Badin

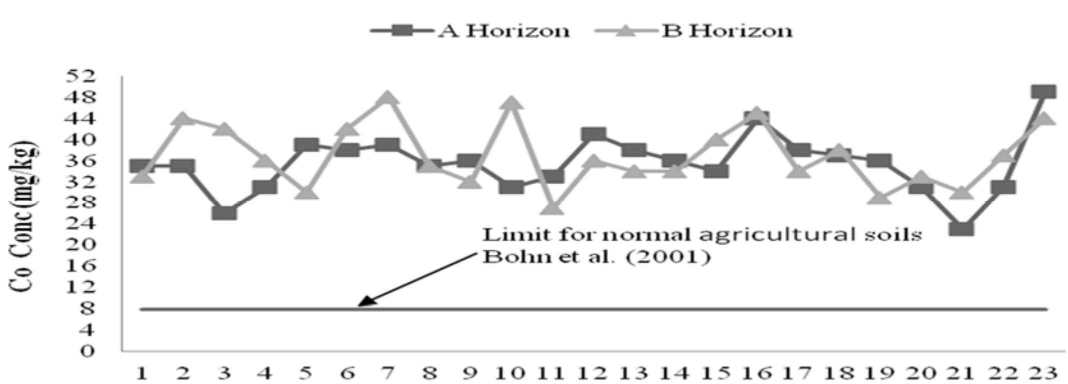

Fig. 8 Cobalt concentrations in the soil samples from various localities of Badin

Chromium (Cr): It is widespread element found in different concentrations in air, water, soil and all biological matters (Adriano, 1986; Jung, 2008)). The level of Cr in soil differs from trace to as high as 5.23%. Soils formed from ultramafic igneous rock generally contain high Cr (Jung, 2008). According to Bohn *et al.* (2001), Cr concentration in normal agriculture soils is 20 mg/kg^{-1}.

(Fig. 7) shows Cr concentration in different soils of Badin. Perceived data shows that it ranges from 29 to 64 mg/kg^{-1} in horizon A and 31 to 68 mg/kg^{-1}. It is evident from figure 6 that all the soil samples collected from different localities of Badin area have high contents of Cr than that of the normal agricultural soil recommended by Bohn *et al.* (2001).

Cobalt (Co): Its concentration in normal agriculture is 8 mg/kg^{-1}(Bohn *et al.,* 2001). **(Fig. 8)** presents Co concentration in different soil samples of Badin area. Co concentration in the soils of study area is ranging between 23 to 49 mg/kg^{-1} in horizon A and 27 to 47 mg/kg^{-1} in horizon B. It is clear from the figure 7 that almost all the soil samples have high contents of Co than that of the normal agricultural soil as recommended by Bohn *et al.* (2001).

The obtained data of this study reveals that heavy metal concentration in the soils of Badin area is beyond the range of normal and safe agricultural soils as suggested by Bohn *et al.* (2001). Municipal waste, industrial wastewater and excessive fertilizers, pesticides are the possible sources of metal pollution in the soils (Ali *et al.,* 2015; de Vries *et al.,* 2007; Sabudak *et al.,* 2007). The waste effluents are main cause of rising level of heavy metals when it is disposed into water systems and when water irrigated lands it further increases the level of heavy metals in soils. The same is also noted in the soil samples of the Badin district. LBOD, KPOD and DPOD and its drainage network may be attributed to the increasing level of heavy metals in the area. Soon after the functioning LBOD, it has the inundated this area many times and its water remained in the area for longtime. Municipal wastewater and different industries of also drain their waste effluents into this canal system. Since the water of this canals system contains several organic and inorganic compound from industrial, municipal and agricultural effluents from Nawabshah, Mipur Khas, Sanghar and Badin district. Therefore, it may be a major cause of enhancing level of heavy metals in the soils of the area.

5. CONCLUSION

On the basis of the data obtained it has been occluded that the heavy metals and trace elements are generally higher in almost all the soil samples of Badin area. The industrial, municipal and agricultural wastes from various sources are responsible for such higher concentration of metals in the studied soils. So far, specific remedial measures such as regular monitoring of the surface and subsurface water and soils of the Badin area are imperative. Those areas where the effects are reaching to hazardous stage should be treated on urgent basis so that the in habitants can be saved from unforeseen disaster.

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