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Research Article

EXTRACTION OF ENVIRONMENTALLY TOXIC HEAVY METALS FROM DIFFERENT FRACTIONS OF SOIL AT INDUSTRIAL REGION

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ABSTRACT
Soil is like measuring meter/ device that tell us overall health of that area. Soil play important role like biomass production controlling and regulating environmental interaction. A soil test is a process by which plant-nutrient elements are extracted from the soil and measured for their "plant-available" content. Soil pollution is mainly caused by the man-made activities which disturbs the natural soil environment. Direct discharge of industrial wastes to the soil, accidental rupture of underground storage links of chemicals or oils, use of pesticides, percolation of contaminated surface water to underground layer are mainly the sources of soil pollution.
Overall soil analysis of industrially polluted area was done to assess the quality of soil with reference to plant growth and human health.

Keywords: *Atomic Absorption Spectrometry, Pesticides, Environment, Heavy Metals, Pollution, Remediation, Soil*

INTRODUCTION
Earth's total surface was covered with a thin layer of organic and inorganic substances known as soil. Among these the organic portion constitutes dead remains of plants and animals which are situated in the uppermost topsoil layer. The term 'Soil' has been coined from Latin word 'Solum', means earthy material necessary for the growth of plants. Soil can define as a mixture of organic and inorganic materials present in the uppermost part of earth crust.
The inorganic portion is derived from rock fragments, which was a result of thousands of years of physical and chemical weathering of rocks. Soil is a vigorous mixture of rock, air and water present in interface. Andriano (2001) illustrated that trace elements also required by organisms at low concentrations. Soil pollution can be defined as long term presence of radioactive materials, toxic compounds like salts and chemicals, heavy metals, or pathogens, which have hazardous effects on plant and animal health. Soil pollution leads to deterioration of the quality of the soil or which and ultimately disturbs the balance of the ecosystem.
Chemicals commonly involved are petroleum hydrocarbons, pesticides, and heavy metals. Their occurrence is depending on the degree of industrialization and quantities of chemical usage. Contaminated soil must not be used for underground water source or agriculture. Because there was leaching of chemicals into the food, water and it was extremely harmful for human health.
Soil is subjected to a number of contaminants due to different man-made activities like industrial, agricultural, transport (Facchinelli *et al*., 2001). The entire composition of soil is environmentally important particularly its heavy metal concentration because heavy metals concentration can directly affect the soil fertility and can also accumulate in to food chain, which ultimately can pose a threat to human health (Facchinelli *et al*., *2001;* Jonathan *et al*., 2004).
These toxic heavy metals which are released into the environment, contribute to a various toxic effect on human being and all ecosystem (Dembitsky, 2003) by the phenomenon of bio-magnification and bioaccumulation (Manohar *et al.*, 2006). Heavy metals are main environmental pollutants, particularly in industrial areas. Conventionally the soil has been used for dumping of the heavy metal wastes before

processing. After that the traditional remediation methods for heavy metal pollution in soil are very expensive and not very eco-friendly (Aboulroos *et al.,* 2006).
Existence of heavy metals in high concentration into the environment results in severe ecological and health problems (Cerbasi and Yetis, 2001). By polluting food chain, these elements became a risk to environmental and human health. Their presence in the ecosystems causes accumulation by living organisms in their bodies. Industrial activities produce effluent with large amount of heavy metals. Thus, environmental cleanup by removal of metals from industrial effluents was a thrust area in today's research.
Industrial development is continuously emerging process in developing countries such as India, but many industries produce harmful wastes and discharge directly in to land. Most of the industries are at the primary phase and cannot manage to pay for as invest in waste matter management and pollution control due to little income edge. Industrial regions are the most important source of hazardous waste production. These regions also contain some of residential area. Thus, there is a big risk of environmental pollution which is very hazardous to our health. Such sites in Bhopal require remediation (Waoo *et al.,* 2014).

MATERIALS AND METHODS

Soil analysis at industrially contaminated area for physiochemical properties as well as heavy metal contamination was carried out.

1.1 Study Area

The study was conducted in Govindpura Industrial Area, Bhopal city which is located between Latitude: 23°16′00″ N and Longitude: 77°24′00″ E Elevation above sea level: 487 m (1597 feet). It is in the central India, and at just north of the upper limit of the Vindhya mountain ranges, located on the Malwa plateau. Govindpura has 1044 small- and medium-scale industries involved in various kinds of production activities. Plate II shows the entrance of Govindpura industrial area.

1.2 Soil Sampling

At an industrially contaminated area Govindpura, five different sites were taken for investigation, where various industries are situated. Soil samples were collected from different sites during March to April from 0–20 cm depth. For each sample, 5-6 sub-samples were randomly collected and combined into a composite sample, and half kg composite sample was taken back to laboratory for sample preparation and analysis. Firstly, stones and plant materials were removed manually. Then soil samples were air dried, then powdered and sieved through a 2 mm sieve. Detailed process of soil sampling, tools required for sampling of soil and the soil analysis for physicochemical properties and heavy metal extraction from soil and plants was described in following sub sections shown by the bullets.

- **Soil Sampling Tools and Accessories**

Soil sampling was done with the help of instruments like *fawda* and *khurpi*, soil augers, spade, shovel etc. It depends upon the availability and sometimes specific purpose.

- **Soil Sampling Method**

The soil sampling method and procedure of obtaining soil samples (Soil testing manual, 2011) vary according to purpose of study. Soil vary from place to place, in view of this sample of soil was taken in such a way that it is fully representative of the whole study area Here sampling was done for heavy metal analysis from soil. Each representative soil sample was collected from 5-6 points in a zone, and mixed thoroughly because an inconsistent or incorrect sampling depth is frequently cited as the major source of soil sampling error. Thus, efficiency of soil analysis depends upon the skill with which soil samples are collected. Non-representative samples constitute the largest single source of error in a study. For soil sample collection, firstly the whole area of Govindpura was divided into four different groups depending upon the specified zone. Sampling pattern was selected to best represent the field. Before taking the particular soil sample, the grass, leaves etc. were removed from the top surface of the soil. After that using a *khurpi* the sample was dug in the form of a V-shaped hole in the soil from the desired depth.

The entire soil ‘wedge’ or slice was collected and similar "wedges" from four spots in the area were taken. The soil from different locations mixed in a zigzag fashion (Figure 3). All the "wedges" mixed together and stones, stalks, leaves were removed. The soil was spread evenly and divided into 4 quarters. Then two opposite quarters were rejected and mixed the rest of the soil again.

The clean and contamination free bag was used for sampling. The soil sample then reduced at about 500-1000 gram and collected in a polythene bag. The bags were clearly labeled as per site so that it can be identified later when test report is received.

- **Soil Sample Preparation for Analysis**

Soil samples for analysis were prepared by drying and post drying care. The soils were dried in the air. The trays were placed in racks in a hot air cabinet whose temperature was not exceeded by 35^0 C and relative humidity was between 30 and 60%.

Air dried samples were ground with a wooden pestle and mortar so that the soil aggregate is crushed but the soil particles do not break down. Soil was filtered through a 2 mm sieve. For trace elements, containers made of copper, zinc and brass was avoided during grinding and handling. After that the soil samples were stored in cardboard boxes in wooden drawers. These boxes were numbered and arranged in rows in the wooden drawers, which are in turn fitted in a cabinet in the soil sample room.

1.3 Soil Analysis

Various characteristic tests were performed on the soil before the heavy metal analysis to characterize the soil and monitor changes that may have occurred during the course of the experiment. The tests performed included: pH, soil texture, moisture content, total organic carbon, C/N ratio, total nitrogen (N), phosphorus (P) and potassium (K) were discussed below in detail, such as Soil Colour and Texture, Soil Temperature, Soil pH, and Organic Carbon.

Estimation of Phosphorous, Nitrogen and Potassium **-** For the analysis of exchangeable phosphorous the solution was prepared by ashing procedure using nitric perchloric and sulphuric acids (Piper 1944). Known capacity of ammonium molybdate was added to develop blue colour and percent transmission of it was measured at 660 mm and the amount was calculated from calibration curve (Jackson 1962). The exchange Potassium was estimated by Flame Photometer following Jackson (1967). The total Nitrogen of the soil was determined by macro-Kjeldahl method was given by Piper (1994).

1.4 Heavy Metal Analysis by Atomic Absorption Spectrometry

Heavy metal concentrations of each fraction were analyzed by Atomic Absorption Spectro photometry. Quality assurance of the observations was guaranteed through repetitive determinations and use of blanks for correction of background and other sources of error.

The presence of heavy metals may vary from site to site, depending upon the source of pollution. The primary sources of heavy metals pollution are industrial waste and dumping actions in certain areas. In soils the concentration of heavy metals persists for a long time after their introduction. Soils represents as the major sinks for heavy metals release into the environment by anthropogenic activities and unlike organic contaminants, most metals do not undergo any type of biological or chemical degradation, thus their total concentration in soils persists for a long time after their introduction. In this study soil was analyzed for heavy metal concentration by atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

According to the results of the soil survey, there are rich soils resources in industrial area, the soils are classed to three major soil types. Soil organic matter content of the study area is generally 1.00%-1.49%, with a maximum content 2.14%, the lowest content is 0.15%; total nitrogen content is about 0.05%-0.07%, the highest level is 0.179%, the lowest is 0.017%, available nitrogen content is between the 61-90 ppm, the highest level reached 108 ppm, the lowest concentration is 8 ppm, soil bulk density is 1.29 g/cm3, porosity is 50.8%, pH value distributed around 8. Soil structure are mostly granular fragments and debris, color is generally brown-red, texture mostly is light soil, medium soil, deep soil, it with a higher degree of physical and chemical properties of production.

1.4.1 Heavy Metal Analysis from Soil

Samples of soil taken from industrial contaminated areas at 4 different places of Govindpura were used as material. The samples were obtained from industrial waste dumping sites and site areas experiencing heavy traffic and residential areas nearby industrial region. The changes in analysis results of heavy metal levels (Pb, Cr, Cd and Ni) in the samples were discussed for samples and sampling places in soil samples. The results of the study showed that heavy metal contents of Pb and Cr are higher than other metals.

These two types of soil samples were collected somewhat outer area (Road side area) of Govindpura region of which had given less concentration of heavy metals as tabulated in Table 1. Therefore, we select the core area of Govindpura near the dumping sites of industrial waste and effluent drainage system for same type of heavy metal analysis study. Figure 1 shows somewhat lower pollution level due to outside region of Govindpura.

Table 1 had shown the very much higher concentrations of heavy metals. The overall analysis had shown that Chromium and Lead had the higher concentration than Cadmium and Nickel. Soil samples S-3 had the highest concentration of Chromium that is 201.9 mg/kg and highest concentration of Lead that is 258.7 mg/kg. The nutrient and heavy metal concentrations in the sediment from sampling sites are graphically represented in Figure 2. In soil samples, the heavy metals were found to be decrease in the order of Pb > Cr > Ni > Cd.

Among the analyzed heavy metals, Pb had the highest concentrations up to 199.5 mg/kg in all the sampling sites and in plants, while Cd shows the low concentrations up to 70.2 mg/kg. Significant variations in heavy metals concentrations ranges were found between these sampling sites except in the case of Pb. Heavy metal concentrations in the industrially contaminated area characterized by the high values of Chromium (up to 209.1mg/kg) and Pb (199.5 mg/kg). These concentrations of heavy metals found in experimental soil samples were higher than threshold values in normal soils.

Table 1: Heavy Metal Analysis of Soil from Contaminated Sites near Road Side

S. No.	Soil Sample	Chromium (mg/kg)	Lead (mg/kg)	Cadmium (mg/kg)	Nickel (mg/kg)
1.	S-1a	56.04	1.09	0.08	59.65
2.	S-2b	50.57	1.42	0.27	50.00

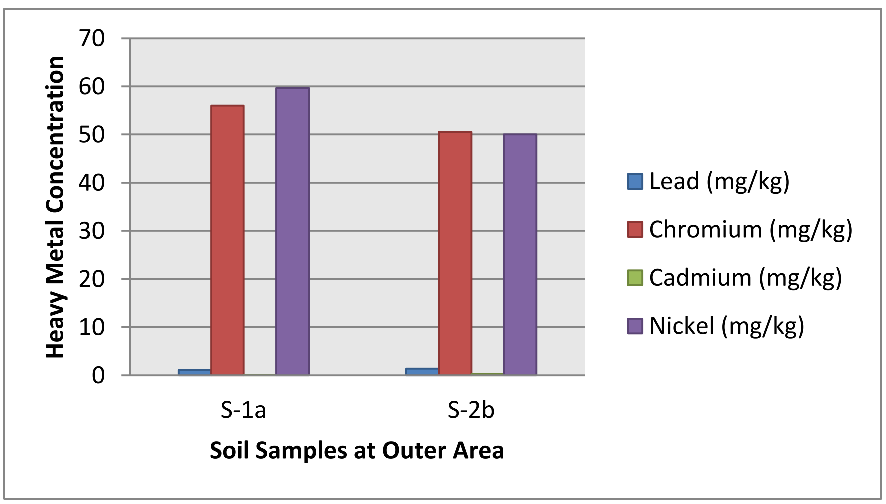

Figure 1: Heavy Metal Analysis from Industrially Contaminated Soil

Table 2: Heavy Metal Analysis of Soil from Contaminated Sites near Dumping Site

S. No.	Soil Samples	Chromium (mg/kg)	Lead (mg/kg)	Cadmium (mg/kg)	Nickel (mg/kg)
1.	S-1	140	199.5	59.2	37.36
2.	S-2	159.8	180.9	70.5	38.5
3.	S-3	201.9	258.7	62.5	32.51

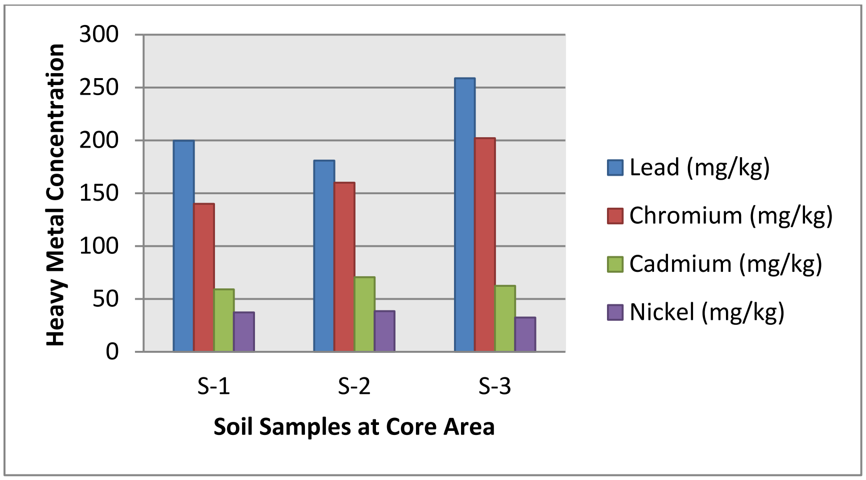

Figure 2: Analysis of Heavy Metals from Soil at Industrially Contaminated Soil

Conclusion

The understanding of the contamination processes of this particular soil herein presented is fundamental for the recovery of extensive polluted areas, as this type of soil is very common in industrialized regions. This research was conducted to determine levels of heavy metal pollution in Govindpura industrial area Thus, the above observations revealed that the soil of core industrial area at Govindpura had heavily contaminated with heavy metals like Chromium and Lead. But Cadmium and Nickel had shown somewhat lower concentrations as compared to Lead and Chromium, this data revealed that industries in Govindpura had waste disposals containing higher concentrations of Lead and Chromium.

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