

# Analysis of Soil of Fazilka District, Punjab, India for Heavy Metal Contamination

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## ABSTRACT

Over the last few decades, study of heavy metal contamination in environment has gained huge importance due to its health related hazards. In the present work, inductively coupled plasma-atomic emission spectrometer has been used to estimate concentration of certain heavy elements (As, Pb, Ni, Zn, Cd and Hg) in the soils of 20 villages of Fazilka district, Punjab, India. Concentrations of As, Ni, Pb, Zn and Cd are below the safe limits suggested by ICRCCL (Interdepartmental Committee for the Redevelopment of Contaminated Land) while concentration of Hg is below the detection limit of the instrument. Anthropogenic activities like industrial waste, improper sewage disposal and vehicle exhausts are the most likely reasons for elevated values at some locations. There seems to be no threat to the inhabitants of the area as far as heavy metal contamination in soil is concerned.

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## 1. Introduction

It is an established fact that serious health problems can be developed in human body as the result of excessive accumulation of heavy elements like Arsenic (As), Lead (Pb), Cadmium (Cd), Nickel (Ni), Zinc (Zn), Mercury (Hg) etc. Heavy metals are extremely persistent in the environment. They are non-biodegradable and non-thermodegradable and thus readily accumulate to toxic levels (Bettinelli et al. 2000). These have long biological half lives and have potential to accumulate in different parts of the body (Wilson and Pyatt 2007). Excessive accumulation of heavy elements in agricultural soils through wastewater irrigation, may not only result in soil contamination, but also affect quality of the food (Islam et al. 2009, Hernandez et al. 2003). Researchers have confirmed that heavy elements like Pb, Zn, Cr and Ni have carcinogenic properties (Kocasooy and Sahin 2007).

Expanding interest in the field of heavy element research is associated with an increasing population of metals, their increased usage in the past century and subsequently with their increasing releases in the environment. This has resulted in a growing hazard to human health. Their persistence in the environment makes their elimination nearly impossible. While usually the natural contributions to the heavy metal concentration in soils are relatively low, a number of anthropogenic activities like vehicle exhausts, emissions of industrial plants, thermal power stations and commercial product waste have made substantial contributions to increase of metal concentrations in soil (Marjanovic et al. 2009).

Use of wastewater for irrigation purposes is a common practice in developing countries like India. To face the growing demand for irrigation water, nonconventional resources are often used. Any type of wastewater available like from domestic activities, small scale industries and due to leakage from damaged pipes and plumbings, is used for irrigation and hence it becomes a potential source of metal contamination in soils (Sharma et al. 2007). However, the intensity of pollution

depends not only on total heavy metal content of the soil, but also on the proportion of their mobile and bioavailable forms, which are generally controlled by the texture and other physicochemical properties of soils. Synergistic effects among metallic pollutants may deteriorate the situation (Imperato et al. 2003).

The heavy metal content of soils may affect public health through direct contact with contaminated soil or by inhalation (Kasassi et al. 2008). Children are the most sensitive target group of exposure. Due to greater sensitivity and behavioral activities, children are at greater risk of toxic element exposure as compared to adults. Consumption of heavy metal-contaminated food can seriously deplete some essential nutrients in the body that are further responsible for decreasing immunological defenses, intrauterine growth retardation, impaired psycho-social faculties, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates (Khan et al. 2008). A number of previous studies have reported heavy metal contamination in soils in many parts of the world (Apeagyei et al. 2011, Adelekan and Abegunde 2011, Yang et al. 2011, Singh et al. 2010, Rottenberg et al. 2007 and Rattan et al. 2005).

The aim of the present study is to investigate the heavy metal pollution in the soil samples collected from 20 villages of Fazilka district, Punjab, India and to look out for possible reasons behind this contamination.

## 2. Study Area

Fazilka district is situated in the South-west part of Punjab state, India. It is surrounded by Ferozepur district in the North, Pakistan in the West, Bathinda district in the East, state of Haryana in the South and Sriganaganagar district of the state of Rajasthan in the South-West direction. For the present study, 20 villages of the Fazilka district in the vicinity of city of Abohar were selected (Figure 1).

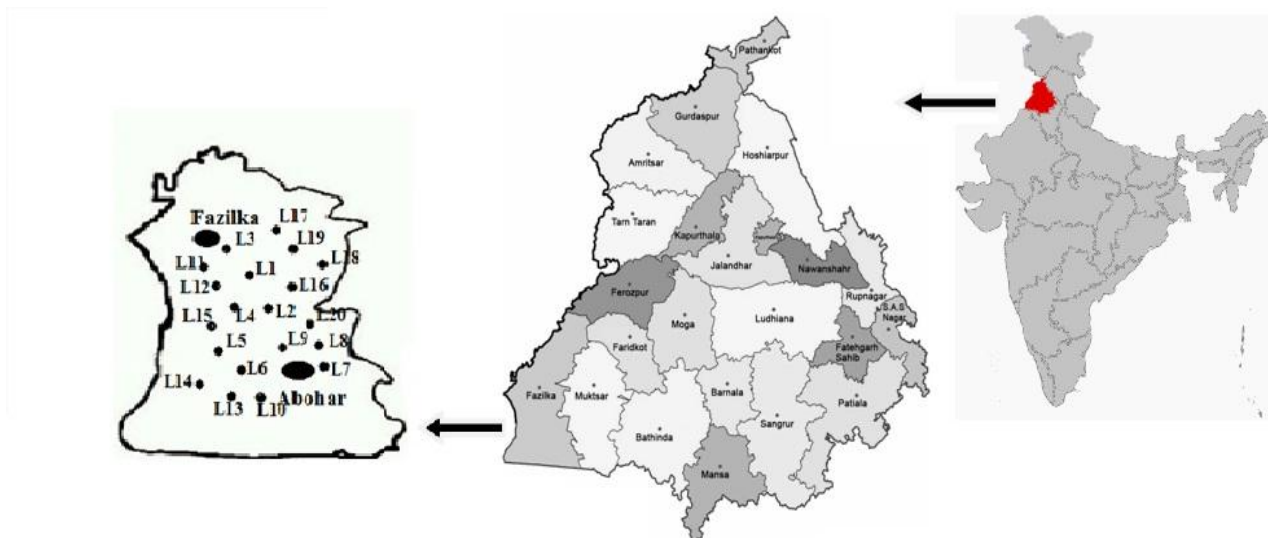


Figure 1. Sampling Area of Present Study

These 20 villages belong to the cancerous belt of India, i.e. the Malwa region of Punjab, which has of late come into limelight for all the wrong reasons. An abrupt rise in the number of cancer patients in this region over the last decade, demands investigation of its abiotic environmental features. This study assesses the soil of this region for possible contamination of heavy elements.

### 3. Experimental Procedure

60 soil samples are collected in 250g plastic bottles from 20 villages of the Fazilka district, Punjab, India. The samples were dried for few days to eliminate moisture content, filtered and stored. For the heavy metal analysis of soil samples, digested filtrates are prepared using DTPA (diethylenetriaminepentaacetic acid) extraction method (Lindsay and Norwell 1978). The extraction solution comprised 0.005 M diethylenetriaminepentaacetic acid (DTPA), 0.01 M calcium chloride dihydrate ( $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ ) and 0.1 M triethanolamine (TEA). 1.97 g of DTPA, 1.47 g  $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$  and 14.92 g TEA were dissolved separately in deionized water and then combined. The pH was adjusted to 7.3 using concentrated HCl and the volume made up to 1 L with distilled water. 10 g of soil was weighed and 20 mL of DTPA extraction solution added. After shaking for 120 minutes, the sample was filtered through with 110 mm diameter filter paper. All the digested filtrates are analyzed to quantify the amount of As, Ni, Pb, Zn, Cu, Cd and

Hg using inductively coupled plasma-atomic emission spectrometer (Thermoelectric make Model ICAP-6300). Argon was used for forming plasma. The system was optimized as per the instructions given in the operating manual and Software supplied for each element. The instrument was calibrated by analyzing solutions with known concentration of heavy metals. All calibration blanks and standards were prepared in the DTPA extraction solution. Prior to starting analysis of sample, a known concentration of each metal was analyzed to examine the instrument's performance.

Inductively coupled plasma atomic emission spectroscopy (ICP-AES) is an analytical technique used for the detection of chemical elements. It is a type of emission spectroscopy that uses the inductively coupled plasma to generate excited atoms and ions that emit radiation at wavelengths characteristic of a particular element. The intensity of this emission is representative of the quantity of the element within the sample. It is the most useful technique for the analysis and quantification of trace elements in both solid and liquid samples. Its applications range from routine environmental analyses to the materials industry, geological applications to clinical research and from the food industry to the semiconductor industry.

Table 1: Heavy metal concentrations measured in soil samples at different locations.

S.No.	Location	Code	Concentration of Element (mg/Kg)					
			As	Ni	Pb	Zn	Cd	Hg
1	Nihal Khera	L-1	9.175	24.45	8.445	50.8	0.695	BDL
2	Dunger Khera	L-2	8.835	24.79	7.88	53.3	0.645	BDL
3	Khui Khera	L-3	5.22	12.94	4.385	34.29	0.375	BDL
4	Chuhri Wala	L-4	9.26	26.13	8.18	52.35	0.64	BDL
5	Panjkoski	L-5	6.5	22.35	6.885	53	0.535	BDL
6	Killianwali	L-6	10.015	26.64	8.845	61.7	0.64	BDL
7	Gobind Garh	L-7	6.565	18.82	5.75	43.83	0.44	BDL
8	Kundal	L-8	7.155	21.15	5.955	44.26	0.48	BDL

9	Mammu Khera	L-9	5.985	17.78	5.055	39.56	0.43	BDL
10	Katian Wali	L-10	7.95	23.91	7.01	49.97	0.575	BDL
11	Ghallu	L-11	9.42	25.81	8.96	54.3	0.645	BDL
12	Jhumian Wali	L-12	9.075	25.74	8.045	54.85	0.595	BDL
13	Roharian Wali	L-13	5.015	13.42	4.495	36.96	0.365	BDL
14	Khipan Wali	L-14	8.25	23.87	7.64	51.7	0.57	BDL
15	Burj Muhar	L-15	5.025	20.84	7.32	56.85	0.53	BDL
16	Katehra	L-16	10.99	24.91	9.63	57.9	0.62	BDL
17	Kamal Wala	L-17	6.375	18.7	6.4	48.24	0.445	BDL
18	Bodi Wala	L-18	7.22	21.3	6.405	49.44	0.48	BDL
19	Patre Wala	L-19	6.31	17.46	5.895	44.44	0.435	BDL
20	Danewala	L-20	7.79	21.49	7.155	51.9	0.53	BDL

BDL = Below detection limit

**4. Results and discussion**

The results of the heavy metal analysis in soil of Fazilka district, Punjab, India are shown in Table-1. As values in soil samples ranged from 5.015 to 10.990 mg/Kg at all the locations. All the values are below the safe limit of 20 mg/Kg (Figure 2) as suggested by ICRL (ICRCL 2016). ICRL has recommended 50mg/Kg as the permissible limit for Ni in soil. All the Ni values are found to be below this limit. All the Pb values in soil samples are much below the safe limit provided

by ICRL (Figure 3). Zn values in the present investigation are also below the recommended value of 105 mg/Kg by ICRL. Cd values in the present study are also well below the permissible value of 56 mg/Kg. Hg values are below the detection limit of the instrument and hence are not recorded. As and Pb contamination in groundwater of the studied area has been recorded earlier (Kumar et al. 2017). But there is no such contamination found as far as soil is concerned.

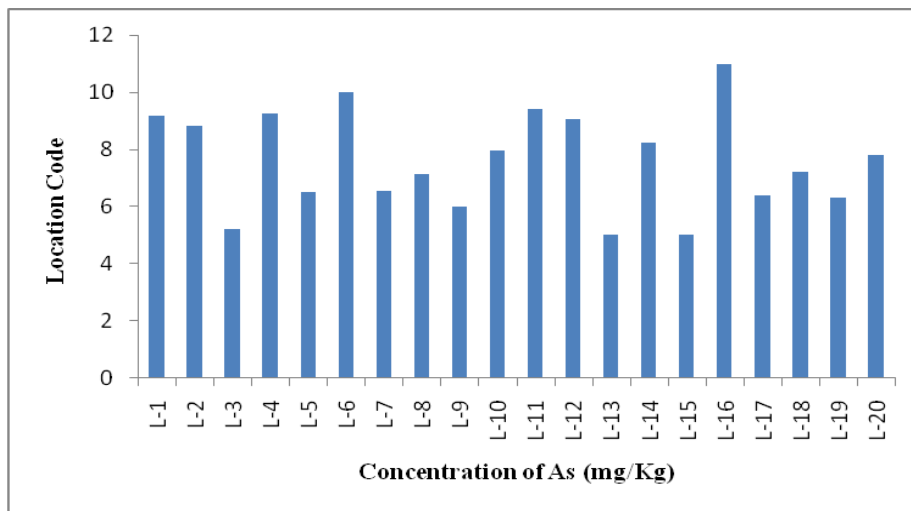


Figure 2: Variation of Arsenic concentration in soil at different locations

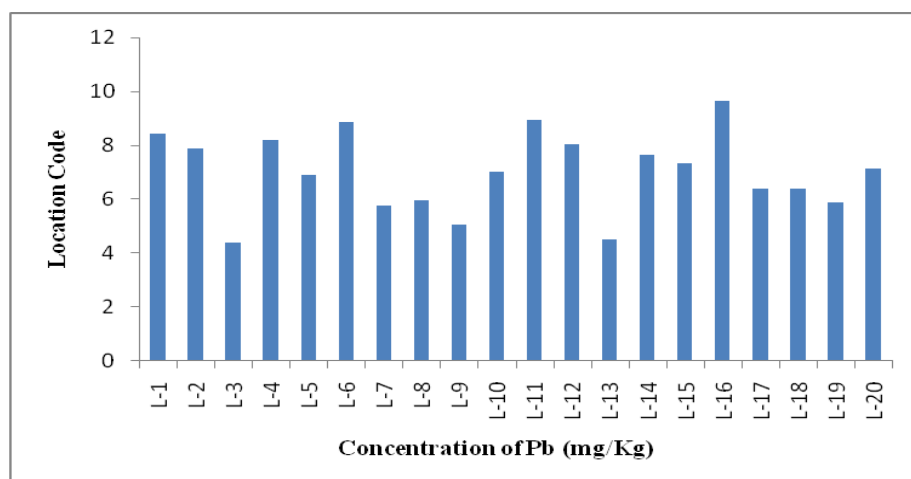


Figure 3: Variation of Lead concentration in soil at different locations

## 5. Conclusions

In the present study, 60 soil samples from 20 villages of Fazilka district, Punjab, India have been analyzed for heavy metal contamination using inductively coupled plasma-atomic emission spectrometer. Results show that all the values of heavy elements As, Ni, Pb, Cd, Zn and Hg are well below the safe limits provided by ICRL. Although As and Pb contamination has been recorded in groundwater of the studied region, no such contamination is found in soil samples. This study recommends further investigation to be conducted on

other health related physical, chemical and biological parameters to find the root cause of ongoing cancer problem in the region.

## Acknowledgement

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