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Comparative Study of Pollutants and Other Parameters of Soil and Water of Urban and Rural Field Area of Haryana (Narnaul and Gurugram)

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ABSTRACT
In the modern world, water has become a major threat. There are multiple ways that some heavy metals are collected and distributed, and some of them have the potential to be hazardous. The world's growing population has accelerated industrialization and development, which is the main cause of water contamination. Heavy metals in lakes, rivers, groundwater, and other water sources are caused by a variety of factors, including the sudden release of mine tailings, the disposal of high metal wastes, the growth of industrial areas, leaded gasoline and paints, the use of fertilizers on land, animal manures, E-waste, sewage sludge, pesticides, wastewater irrigation, coal, etc. The same is true with heavy metals, which affect the quality of crops and vegetables by penetrating the soil. This chapter is primarily concerned with the detrimental effects that heavy metals and other water contaminants have on living organisms. Acute and chronic exposure to heavy metals has been linked to brittle bones, neurotoxicity, kidney, liver, and lung damage, retardation, and even the potential for death in extreme exposure situations.

KEYWORDS: Heavy metals, toxicity, water, soil, Ph, conductivity

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INTRODUCTION

Lanthanides, actinides, basic metals, transition metals, and certain metalloids are examples of heavy metals. The primary elements that are classified as heavy metals include mercury (Hg), molybdenum (Mo), copper (Cu), zinc (Zn), cobalt (Co), manganese (Mn), and chromium (Cr), cadmium (Cd), lead (Pb), antimony (Sb), tin (Sn), nickel (Ni), and so forth. Heavy metals may be divided into three categories: radionuclides (like U, Th, Ra, Am, etc.); valuable metals (like Pd, Pt, Ag, Au, Ru, etc.); and poisonous metals (like Hg, Cr, Pb, Zn, Cu, Ni, Cd, As, Co, Sn, etc."). On the toxicity list, "the big three," lead, chromium, cadmium, and mercury, are at the top and make headlines because of their significant environmental impacts. The long-term use of sewage sludge will harm plants and the environment because it contains polluted organics like hormones, antibiotics, endocrine disruptors, and persistent organic pollutants (POPs), as well as toxic low-molecular weight compounds like polychlorinated biphenyls (PCB) and polynuclear aromatic hydrocarbons (PAHs). Even though sewage sludge can transport nutrients for plant growth and development, B. Nrgholi (2007). Heavy metals are highly dangerous to plants and people when consumed in excess of permitted levels. Significant quantities of these heavy metals are released into the environment as a result of several human-caused activities. Numerous investigations have revealed that heavy metals have harmful or hazardous effects. Both plants and microorganisms are harmed by them because they have a direct impact on physiological and biochemical processes that hinder growth, degrade cell organelles, and hinder photosynthesis. Due to the potential for heavy metal contamination of food through soil-root contact, they are particularly detrimental to agricultural plants. Plants absorb and deposit heavy metals at greater levels even if they are not necessary for plant growth because of the complex interactions between main detrimental ions and other essential or non-essential ions (Ahmadpour, P et al., 2012). Cells and tissues suffer toxic damage as a result. When soil and water are contaminated by heavy metals and trace elements, the plant system absorbs and accumulates these dangerous compounds. The biomagnification causes serious and dangerous ailments when people consume these infected veggies for a long period of time. Pollution from heavy metals is a major problem nowadays. Their environmental endurance and toxicity make them the primary source of soil contamination (M. Uchimiya, et al., 2020). Air deposition, sewage sludge, farmyard manure, the widespread use of synthetic fertilizers, and rapid industrialization are some of the factors that contribute to the presence of heavy metals (HMs) in soils (M.R. Mehr et al., 2021; J. Xu et al., 2019). Hard metals (HMs), such as lead (Pb), nickel (Ni), arsenic (As), zinc (Zn), copper (Cu), cadmium (Cd), chromium (Cr), and mercury (Hg), impact over 20 million hectares (ha) of land (L. Liu et al., 2018). Heavy metal pollution is one of today's most significant issues. Soils are contaminated mostly by them due to their toxicity and environmental persistence. Heavy metals (HMs) are found in soils due to a variety of sources, including air deposition, sewage sludge, farmyard manure, rapid industrialization, and the use of synthetic fertilizers. More than 20 million hectares (ha) of land are affected by lead (Pb), nickel (Ni), arsenic (As), zinc (Zn), copper (Cu), cadmium (Cd), chromium (Cr), mercury (Hg), and other heavy metals (HMs). The World Health Organization (WHO] has already expressed concern about the harm that trace metals such as arsenic, lead, cadmium, and chromium are causing to ecosystems in many countries (WHO, 2021). Heavy metals (HMs) and metalloids are classified as agricultural soil contaminants due to their potential to negatively impact crop health and yield in the event of excessive soil concentrations (M. Shahid, et al. 2015; A. Rashid et al. , 2023). Because they are hard to decompose, heavy metals (HMs) can build up in the soil and stay there for a long period if plants don't absorb or drain them (R.A. Wuana et al., 2011; N.H. Ghori et al., 2011; H. Ali et al., 2011). Commonly found in agricultural soils are high concentrations of elements that are harmful to plants, such as Ni, Cd, Hg, Cu, Cr, As, Pb, and Zn (G. T´oth, et al., 2016). For plants, Cr, Cd, Hg, As, and Pb are especially poisonous and detrimental at almost all levels of pollution (S. Tiwari & C. Lata, 2018; P.K. Rai et al. 2019; S. Singh et al., 2016). Soil contamination has an over-standard rate of 16.1%, whereas the over-standard rates for HMs Cr, Cd, As, Pb, and Hg are 1.10%, 1.50%, 1.60%, 2.70%, and 7.00%, respectively (H. Zhao et al., 2022). Historically, these HMs have generally been absorbed by the earth.On the other hand, extended exposure to heavy metals might result in bone fractures and lung cancer. Concerns about the usage of popular goods contaminated with heavy metals (HMs), such as fruits and vegetables, have grown dramatically in the last several decades. Rapid absorption of Pb, Cd, and As occurs in the food chain. Lead and cadmium are detrimental to the kidneys, heart, and auditory systems, and they can induce retardation in children because of their rapid accumulation in tissues. Compared to adults, children are at greater risk from these medications (S. Hembrom et al., 2020). Heavy metals are described by Ferguson (1990) as natural elements having a significant atomic weight (Fergusson, 1990) and a density at least five times that of water. Metalloids including tellurium, antimony, selenium, germanium, and arsenic are also considered heavy metals because of the belief that toxicity and big weight are connected. These metalloids can be harmful in vivo at low exposure levels (Duffus, 2002). Heavy metals penetrate the earth's crust frequently since they are naturally occurring components. However, heavy metal enrichment effects in the environment can be maximized globally through residential, industrial, military, medical, technical, and agricultural activities and applications (Tchounwou et al., 2012). Consuming excessive amounts of heavy metals can have detrimental and carcinogenic consequences, even if some are necessary for life (Jaishankar et al., 2014). They are also linked to certain acute and chronic conditions, such as hypertension (Martins et al., 2018). cardiovascular disease (Moreno et al., 2019); endocrine disruption (Stevenson et al., 2019); renal failure; infertility; bone abnormalities; atherosclerosis (Yang et al., 2016). Diabetes inflammatory response (Pollard et al., 2019); neurological conditions autoimmune diseases; and high blood sugar levels. Heavy metals are obviously toxicants and very dangerous risk factors (Mishra et al., 2019). For instance, lead, cadmium, mercury, nickel, copper, and cadmium (Hubicki and Kołodyńska, 2012). Vehicle emissions, landfill seepage, sewage sludge, quick industrialization, urbanization, and the use of agrochemicals have all contributed to Haryana's high level of pollution. Urban soils, which collect dangerous Pb, Cd, Cu, Zn, and Ni near industrial zones and roads, are most affected. The soil and water samples were collected by the author of this study work from Haryana's rural (Vill. Mandhana) and urban (Gurugugram) arable fields. Heavy metal concentrations in soil and water samples were examined in conjunction with other variables.

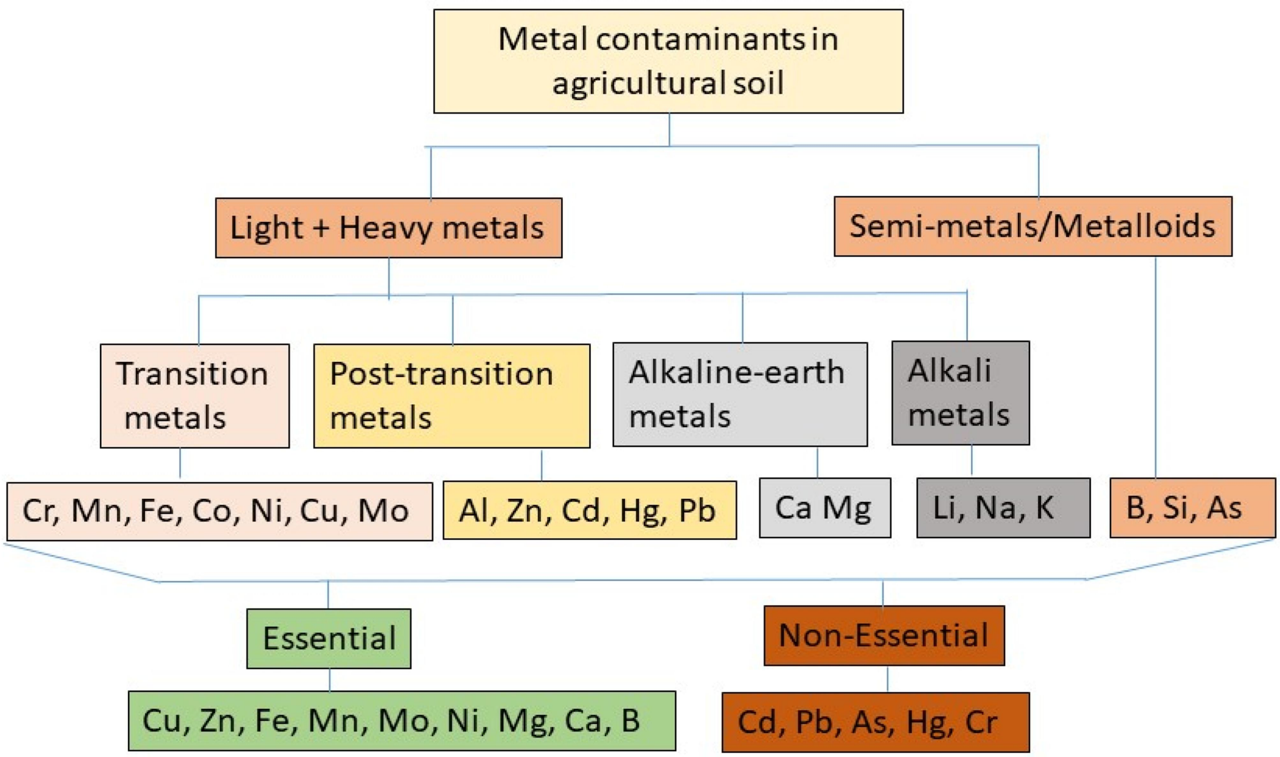

Figure 1: distinguishing between metallic and non-metallic components that are frequently present in agricultural soils. Aluminum, lithium, potassium, sodium, silicon, manganese, zinc, copper, lead, nickel, chromium, arsenic, magnesium, calcium, iron, boron, manganese, manganese, manganese, and zinc

MATERIALS AND METHODS

Study Site:

Samples were collected from arable land of urban (Gurugram) and rural (Vill. Mandhana) area of Haryana.

Image 1: Urban Area Sampling Site **Image 2: Rural Area Sampling Site**

Sampling and Analysis:

Soil: Soil samples collected from both the sites at multiple depths in triplets.

Water: Water Samples collected from both the sites from source of irrigation in triplets.

RESULTS

Table 1: Showing the results of soil sample of rural area

S. No.	Parameters	Test Method	Results	Units
1	Ph (at 25°C)(1:2.5 soil water sus.)	IS: 2720 (Part-26)	9.14	-
2	Conductivity (1:2 soil water sus.)	IS: 14767	0.09	mS/cm
3	Available Potassium	Method Manual of Soil testing of India, (Department of Ag, and Corporation Ministry of Ag. Govt. of	144.70	Kg/hec.
4	Organic Matter	IS: 2720 (Part-22)	0.59	%
5	Available Nitrogen	Method Manual of Soil testing of India, (Department of Ag, and Corporation Ministry of Ag. Govt. of	192.17	Kg/hec.
6	Available Phosphorous	Method Manual of Soil testing of India, (Department of Ag, and Corporation Ministry of Ag. Govt. of	14.08	Kg/hec.
7	Total Lead	USEPA 3050 B	BDL(DL 5.0)	mg/kg
8	Total Cadmium	USEPA 3050 B	BDL(DL	mg/kg

			5.0)	
9	Arsenic	USEPA 3050 B	BDL(DL 5.0)	mg/kg
10	Mercury	USEPA 3051 A	BDL(DL 5.0)	mg/kg

BDL: Below Detection Level DL: Detection Limit

Table 2: Showing the results of soil sample of urban area

S. No.	Parameters	Test Method	Results	Units
1	Ph (at 25^{o}C)(1:2.5 soil water sus.)	IS: 2720 (Part-26)	8.26	-
2	Conductivity (1:2 soil water sus.)	IS: 14767	0.55	mS/cm
3	Available Potassium	Method Manual of Soil testing of India, (Department of Ag, and Corporation Ministry of Ag. Govt. of	122.57	Kg/hec.
4	Organic Matter	IS: 2720 (Part-22)	0.79	%
5	Available Nitrogen	Method Manual of Soil testing of India, (Department of Ag, and Corporation Ministry of Ag. Govt. of	195.15	Kg/hec.
6	Available Phosphorous	Method Manual of Soil testing of India, (Department of Ag, and Corporation Ministry of Ag. Govt. of	16.13	Kg/hec.
7	Total Lead	USEPA 3050 B	7.88	mg/kg
8	Total Cadmium	USEPA 3050 B	BDL(DL 5.0)	mg/kg
9	Arsenic	USEPA 3050 B	BDL(DL 1.0)	mg/kg
10	Mercury	USEPA 3051 A	BDL(DL 1.0)	mg/kg

BDL: Below Detection Level DL: Detection Limit

Table 3: Showing the results of water sample of rural area

S. No.	Test Parameters	Test Method	Results	Units	Specifications as per IS10500 2012	
					Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source
1	Ph	IS 3025 (Part-11)	7.14	--	6.5-8.5	No Relaxation
2	Conductivity	IS 3025 (Part-14)	1392.0	µS/cm	--	--
3	Total Suspended Solid	IS 3025 (Part-17)	29.0	mg/l	--	--
4	Arsenic	IS 3025 (Part-37)	BDL(DL 0.002)	mg/l	0.01	No Relaxation
5	Mercury	IS 3025 (Part-	BDL(DL	mg/l	0.001	No Relaxation

		48)	0.001)			
6	Cadmium	IS 3025 (Part-41)	BDL(DL 0.002)	mg/l	0.003	No Relaxation
7	Lead	IS 3025 (Part-47)	BDL(DL 0.008)	mg/l	0.01	No Relaxation
8	Chemical Oxygen Demand (COD)	IS 3025 (Part-58)	3.1	mg/l	--	--
9	Biological Oxygen Demand (BOD)	IS 3025 (Part-44)	BDL(DL 1.0)	mg/l	--	--

BDL: Below Detection Level   DL: Detection Limit

Table 4: Showing the results of water sample of urban area

S. No.	**Test Parameters**	**Test Method**	**Results**	**Units**	**Specifications as per IS10500 2012**	
					Requirement (Acceptable Limit)	**Permissible Limit in the Absence of Alternate Source**
1	Ph	IS 3025(Part-11)	6.89	--	6.5-8.5	No Relaxation
2	Conductivity	IS 3025(Part-14)	3650.0	µS/cm	--	--
3	Total Suspended Solid	IS 3025(Part-17)	9.0	mg/l	--	--
4	Arsenic	IS 3025(Part-37)	BDL(DL 0.002)	mg/l	0.01	No Relaxation
5	Mercury	IS 3025(Part-48)	BDL(DL 0.001)	mg/l	0.001	No Relaxation
6	Cadmium	IS 3025(Part-41)	BDL(DL 0.002)	mg/l	0.003	No Relaxation
7	Lead	IS 3025(Part-47)	BDL(DL 0.008)	mg/l	0.01	No Relaxation
8	Chemical Oxygen Demand(COD)	IS 3025(Part-58)	2.0	mg/l	--	--
9	Biological Oxygen Demand(BOD)	IS 3025(Part-44)	BDL(DL 1.0)	mg/l	--	--

BDL: Below Detection Level   DL: Detection Limit

DISCUSSION

- Urban versus Rural soil: Ph of rural soil sample is high as compare to urban. Conductivity and organic matter is high in urban soil but if we see concentration of lead then the clear difference can be observed. It is too high in urban soil sample due to high pollution and that is the matter of concern.
- Urban verses rural water: In this all results under acceptance limit.

  Ecological and Health risks: The health of ecosystems and urban agriculture are threatened by contaminated soil, and children's cardiac, neurological, and developmental development may be impacted by drinking contaminated groundwater.

RECOMMENDATIONS

a) **Monitoring:** Systematic heavy metal surveillance in soil and water, especially near urban/ industrial hotspots.

b) **Phytoremediation:** Deploy heavy-metal accumulating plants (eg: Indian mustard, sunflower) for contaminated soils and shallow water.

c) **Regulation:** Enforce industrial effluent standard; manage landfill leachate(eg., Bandhwari) to prevent groundwater pollution.

d) **Safe water supply:** Install community water treatment systems in rural areas where HI>1 is detected.

e) **Farmer training:** Promote judicious agrochemical use and soil testing to reduce mobile heavy metals.

f) **Policy integration:** Formulate regional policies linking urban-rural contamination data for coordinated risk management.

CONCLUSION

The comparison of soil and water quality metrics between the rural Narnaul area and the urban Gurugram area indicates notable geographical differences caused by anthropogenic activities, land use patterns, and population density. With its fast industrialization and urbanization, Gurugram showed increased levels of pollutants such nitrates, heavy metals, and chemical oxygen demand, indicating significant environmental stress on water and soil systems. With its primarily agricultural terrain, Narnaul, on the other hand, displayed relatively lower pollution levels but raised issues with agricultural runoff, specifically high levels of phosphate and nitrate. These findings highlight the necessity of region-specific environmental management techniques; although rural regions need better agricultural practices and runoff control, urban areas must emphasize wastewater treatment, industrial regulation, and sustainable urban development. According to this comparative analysis, industrial activity and improper waste management are the main causes of the considerable heavy metal contamination found in Haryana's urban soil, whereas agricultural activities are mostly responsible for the moderate contamination of rural soils and irrigation water. To protect the environment and public health in Haryana, increased monitoring, efficient remediation, regulatory action, and community awareness campaigns are essential.

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