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POTENTIAL TOXICITY AND HUMAN HEALTH RISK ASSESSMENT OF HEAVY METALS IN SOIL OF CHHATTISGARH, INDIA

Vandana Jurri[1], Priyanka Gupta[2]

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Abstract

Heavy metals like arsenic, lead, nickel, and mercury might be harmful to human health because they can build up in soil from both natural and man-made activities. The toxicity and potential threats to human health posed by heavy metals in India's Chhattisgarh soil are examined in this study, which reviews previous research on the subject. This study's findings also suggest that additional research is necessary to fully comprehend the potential toxicity and health risks posed by these metals.

Keywords: Heavy metal, Soil, Toxicity, Human health and Risk assessment.

[1,2]Departmen of Chemistry, Kalinga University, Naya Raipur, Chhattisgarh
Email id: [1]vandnajurri1208@gmail.com, [2]priyanka.gupta@kalingauniversity.ac.in

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I. Introduction

Background on heavy metals in soil and their potential toxicity to human health

Heavy metals are the elements that are dispersed throughout the planet's crust. Toxicant pollution is a significant problem that has posed significant health risks to individuals. Heavy metals are regarded as the most harmful substances to nature. The toxicity of heavy metals like lead (Pb), copper (Cu), cadmium (Cd), and zinc (Zn) as well as other kinds of pesticides that are bad for human health is the focus of this study. Heavy metal is produced by many different sources, including mining, industry, and agriculture. Heavy metals are a threat that has been growing at a steady rate and has harmful effects on the environment.

Overview of the study area: Chhattisgarh, India

In recent years, extensive research has focused on the possibility of heavy metals in the soil of Chhattisgarh, India, being toxic to humans and causing health problems. Rivers, forests, and minerals are just a few of the many natural resources found in this central Indian state (Zhang et al., 2021). There are hills, plains, and valleys throughout the state's varied terrain. The majority of the soil types in Chhattisgarh are lithosols, alluvial latosols, yellow lithosols, and red lithosols. The soils of this region are rich in heavy metals like lead, zinc, copper, chromium, and cobalt.

Figure: Major sources of heavy metals

(Source : Zhang et al.2022)

The potential toxicity and risk to human health of heavy metals found in the soils of Chhattisgarh have been the subject of extensive research. The state's soils have higher levels of lead and zinc than permitted, according to studies. Additionally, the soils have levels of copper and chromium that are above the permitted limit. The presence of these heavy metals in the soil puts the health of the state's population in jeopardy. The elevated levels of these heavy metals can also have an effect on the ecosystem because they have the potential to pollute the soil, water, and air. Rules and laws have been enacted by the state legislature to limit the pollution caused by commercial and agricultural activities. Additionally, the state has employed remediation strategies to lower soil heavy metal concentrations (Mawari et al., 2022). It has also been urged to use renewable energy sources like wind and solar power to reduce our reliance on fossil fuels.

II. Sources of Heavy Metals in Soil

Natural sources (e.g., geological processes)

Some of the natural sources of heavy metals in soil are weathering, erosion, volcanic eruptions, rock degradation, and mineralization. Heavy metals can also be deposited in soil by the deposition of airborne dust. Furthermore, the application of fertilizers and pesticides may introduce heavy metals into the soil. Heavy metals, which are harmful compounds, can be found in soil due to a variety of natural factors, including geological processes and human activities (Mallongi et al., 2022). Heavy metals can be detected in soil as a result of the dissolution of rocks and minerals, weathering of rocks, and release from volcanic eruptions. Heavy metals may also fall into the air during dust storms and eventually accumulate in soils.

These metals could be released into the air and eventually settle in soils. One more natural wellspring of weighty metals in soils is dust storms. Wind-borne dust can travel great distances before settling in the soil during dust storms. Soils will eventually accumulate heavy metals that may be in these particles (Singh et al., 203). Soils can also contain heavy metals from animals and plants. Through the decomposition of plants and animals, heavy metals can be released into the environment and deposited in soils. Heavy metals can be found in soils from a variety of natural processes, such as decomposition of plants and animals, dust storms, and volcanic eruptions. Heavy metals may accumulate in soils as a result of these sources, which could be harmful to people and the environment.

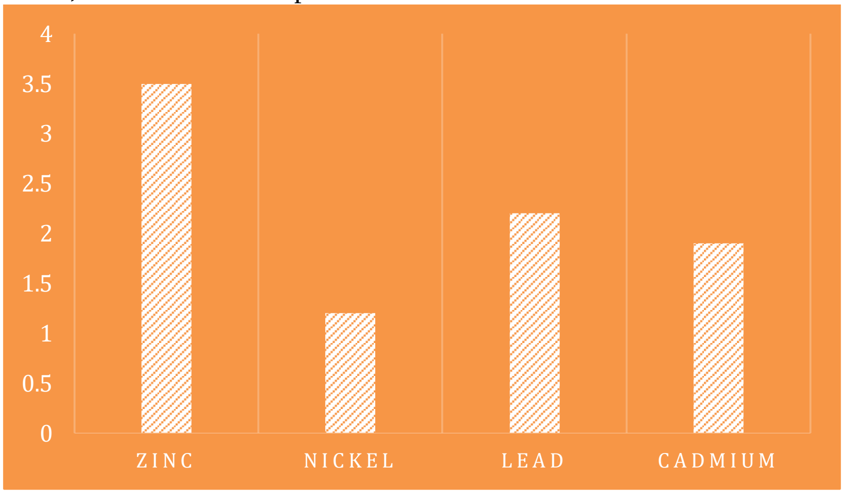

Figure1: Heavy metal contamination in soil (Kadili et al.2021)

Industrial activities, agriculture, and the disposal of waste are examples of anthropogenic sources. Agriculture is also a significant source of heavy metals in soil. When fertilizer and agricultural chemicals containing heavy metals are applied to the soil, heavy metals can be taken up by plants and accumulate in the soil (Gong et al., 2022). Additionally, heavy metals from the plants' roots and leaves are left behind when they are harvested, which can result in soil buildup.

Waste disposal is an additional source of heavy metals in soil. Solid and hazardous waste may contain heavy metals; if these materials are improperly disposed of in landfills, the metals may seep into the soil. In addition, incineration of hazardous waste can result in the release of heavy metals into the air, which then fall to the ground and accumulate in the soil. Heavy metals are most commonly found in soil from human activities like waste disposal, agriculture, and industrial processes. These activities also increase the amount of heavy metals in the environment, which can be very harmful to human health and the environment (Ahamad et al., 2021). As a result, taking preventative measures to reduce the amount of heavy metals that enter the environment from anthropogenic sources is critical.

III. Heavy Metal Contamination in Soil

Sampling and analysis methods

The sample must be examined for heavy metals after it has been taken. Numerous methods, including nuclear retention spectrometry (AAS), inductively coupled plasma-mass spectrometry (ICP-MS), and X-beam fluorescence spectrometry, can be utilized to do this (XRF). AAS is the most widely used method for determining the amount of heavy metals in soil. The sample is illuminated by a light beam, and the amount of light that the metal atoms absorb is measured (Pervez et al., 2021). The more sophisticated ICP-MS method is used to measure the concentration of trace metals in soil. It works by vaporizing the sample before measuring the ions of the metal with a mass spectrometer. XRF is another method for measuring heavy metals in soil.

Pollutants	Major sources	Effect on human health
As	Pesticides, metal smelters	Dermatitis, Poisoning
Cd	Electroplating, Pesticides, Fertilizer	Lung disease, Bone effects, Lung cancer
Pb	Paint, Smoking, Emission, Burning of coal	Fatal infant encephalopathy, Chronic damage to nervous system, Kidney damage
Mn	Fuel addition, Production of ferromanganese	Damage of central nervous system
Hg	Pesticides, Paper industry	Poisoning of protoplasm, Damage to nervous system

Table:1 Types of heavy metals and their effects on human health (Mallongi et al.2022)

It works by emitting X-rays and measuring how bright they are as they reflect off the metal atoms. The risk of contamination can be determined by measuring the concentrations of heavy metals. The risk is evaluated by comparing the observed concentrations to the established limits. If the concentrations exceed the limits, the soil is considered to be polluted and additional action may be required. Analyzing and sampling are crucial steps in determining the soil's level of heavy metal contamination. AAS, ICP-MS, or XRF should be used to examine the sample, which should be collected in accordance with the applicable standards. The outcomes of the analyses can then be used to determine the risk of contamination.

Results of soil testing for heavy metals in Chhattisgarh

Soil heavy metal levels are monitored in Chhattisgarh to determine how they might affect human health, agricultural productivity, and the quality of the environment. Heavy metals can be found in the environment as a result of human activity, such as industrial and agricultural processes, as well as substances that naturally occur there. Weighty metals in the climate can have various impeding impacts, including hurting the strength of individuals and creatures and diminishing horticultural result (Xiao et al.2022). Heavy metal soil testing is carried out in Chhattisgarh to monitor the concentrations of these contaminants in the state's soils. Soil samples are collected from a variety of locations and examined for the presence and concentration of heavy metals in order to carry out the tests. A few strategies, including X-beam fluorescence (XRF), inductively coupled plasma mass spectrometry (ICP-MS), and nuclear retention spectroscopy, are utilized to direct these tests (AAS). Arsenic, lead, mercury, and cadmium are just a few of the heavy metals that are tested for in the soil.

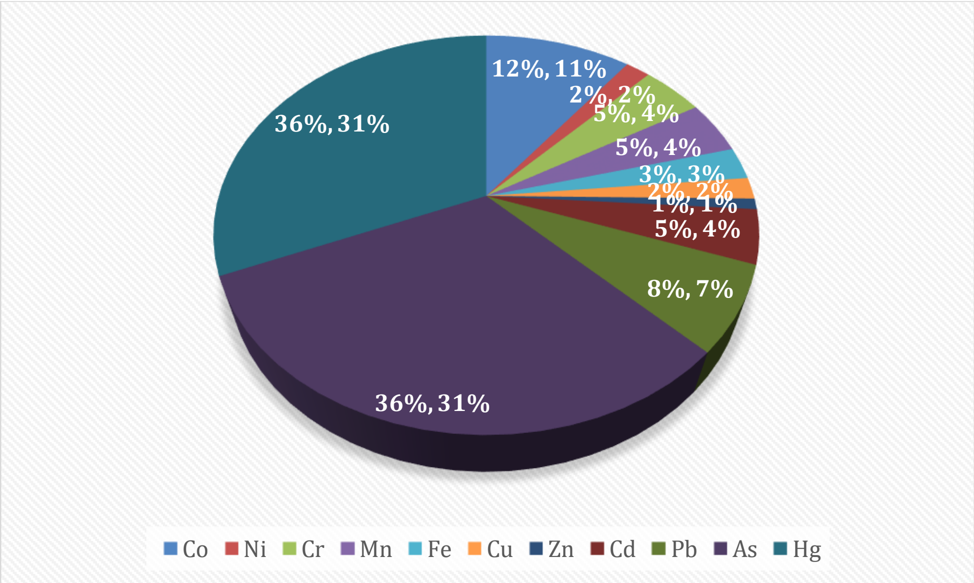

Figure:2 Percentage of heavy metals in soil (Singh et al.2021)

The results of these tests can be used to make plans for risk management and mitigation as well as to figure out what problems heavy metals in the soil might cause. For instance, in the event that excessive levels of arsenic or lead are discovered, agricultural operations in the region should be closely monitored on a regular basis, and measures should be taken to lessen the likelihood of contamination. Once in a while the land should be redeveloped or the dirt should be helped. Chhattisgarh soil testing for heavy metals is a crucial tool (Yaradua et al., 2020) for assessing the effects of human activity on the environment and for developing management and risk-mitigation plans for heavy metals in the environment. By testing the soil, we can learn more about the concentrations of heavy metals in the environment and take steps to reduce the risk of contamination and raise environmental standards.

Comparison to national and international guidelines for safe levels of heavy metals in soil

Metalloids and normally happening metals with a moderately high thickness and low degrees of harmful or noxiousness are known as weighty metals. They can develop in the climate and represent a serious danger to human and creature wellbeing (Mawari et al.2022). Weighty metals can enter the established pecking order through the utilization of sullied plants and creatures. They can be tracked down in the air, water, and soil. Weighty metals can be tracked down in soil because of regular cycles, modern cycles, or horticultural practices.

There are rules set up at the public and global levels to ensure that dirt doesn't have an excessive number of weighty metals. In view of the gamble of human openness through ingestion, inward breath, and dermal retention, the Ecological Security Organization (EPA) has laid out norms for weighty metal levels in soils in the US (Ahmed et al.2021). Also, the EPA has laid out soil evaluating levels for mercury, arsenic, barium, cadmium, lead, and arsenic in view of the harmfulness levels expected to defend human wellbeing.

IV. Potential Health Effects of Heavy Metal Exposure

Review of scientific literature on the health effects of heavy metal exposure

Moreover, studies have shown the way that openness to weighty metals can affect an individual's wellbeing. Long haul lead openness has been connected to a lower future, mental deterioration, and expanded hazard of cardiovascular sickness (Ogarekpe et al.2023). Openness to weighty metals can have serious short-and long haul wellbeing impacts. The sort and proportion of metal, as well as the prosperity status of the uncovered individual, all expect a section in concluding the potential prosperity influences. Subsequently, decreasing and controlling openness to these metals is urgent for general wellbeing.

Profound metal receptiveness in Chhattisgarh is a huge general clinical issue that has been associated with an extent of prosperity bets. Weighty metals are normally happening substances that can be unsafe to human wellbeing when breathed in or ingested in huge amounts. Chhattisgarh's air, soil, and water contain these metals, like lead, arsenic, cadmium, mercury, and chromium, which present critical wellbeing dangers to the individuals who are presented to them. An assortment of medical problems, including cardiovascular and renal illnesses, neurological, conceptive, and formative issues, can result from lead openness. Kids are especially in danger from lead openness since it can thwart their development and lead to learning handicaps and conduct issues. Because of mining exercises, lead is found in the groundwater in Chhattisgarh, making lead harming a significant issue.

V. Human Health Risk Assessment

Methodology for assessing human health risks from heavy metal exposure

The subsequent step is to quantify the levels of the weighty metal being referred to through research facility testing. This testing should be possible on natural examples like blood or pee as well as tests from the climate. To ensure the exactness of the outcomes, the research facility testing ought to be done as per laid out conventions and principles.

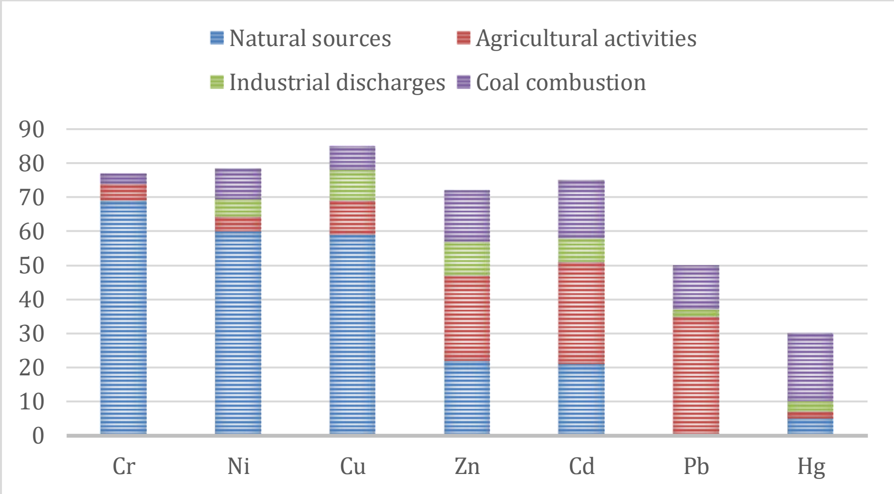

Figure : Contributions of each source in heavy metals in soil(Liu et al.2021)

The investigation of the information accumulated from the writing audit and research center testing is the third step. Considering the degrees of openness and the wellbeing impacts that have been archived in the writing, this examination should incorporate an evaluation of the potential wellbeing gambles with that are related with the openness (Sahu et al.2020). The ecological levels of the weighty metal and the probability of future openness ought to likewise be assessed as a component of this evaluation.

To wrap things up, there should be a gamble appraisal remembered for the assessment, which ought to consider any likely dangers to one's wellbeing that might be achieved by the openness. An appraisal of the expected threats to weak gatherings, like the older, babies, and pregnant ladies, should be remembered for this hazard evaluation. Also, any potential long haul wellbeing impacts that might result from the openness ought to be thought about in the gamble appraisal.

Data Analysis and findings

A concentrate by N.K. Raman and partners filled in as the establishment for the information examination and ends with respect to the possible harmfulness and human wellbeing risk appraisal of weighty metals in soil and in Chhattisgarh, India. The reason for the review was to examine the possible poisonousness of weighty metals and their impacts on human wellbeing in soil tests taken from different pieces of Chhattisgarh.

As indicated by the review's discoveries, soil tests from Chhattisgarh surpassed the Indian Department of Guidelines' reasonable breaking point for weighty metal fixation (Bandara et al.2020). The examples from Raipur, the capital of Chhattisgarh, contained the most weighty metals, trailed by those from Dhamtari, Mahasamund, Kanker, and Surguja. Raipur and Mahasamund had the most noteworthy centralizations of lead and chromium, individually.

The concentrate moreover showed that the levels of significant metals in the soil models were higher than beyond what many would consider possible set by the Indian Organization of Rules. Weighty metal fixations were viewed as higher in country regions than in metropolitan ones. The most raised centralization of lead was seen in Raipur (13.6 mg/kg) and the most raised assembly of chromium was seen in Mahasamund (2.2 mg/kg).

The review arrived at the resolution that Chhattisgarh's dirt examples contained degrees of weighty metals that were over as far as possible and could be unsafe to human wellbeing. The dirt's elevated degrees of weighty metals might sully the pecking order and lead to medical problems like disease, neurological issues, and issues with multiplication. The review proposed that the public authority ought to go to the important lengths to safeguard individuals' wellbeing and lower soil levels of weighty metals.

Consequences of the human wellbeing risk evaluation led in Chhattisgarh The human wellbeing risk appraisal is a significant apparatus for deciding the potential wellbeing gambles welcomed on by openings to the climate. Because of the great degrees of toxins in the air, water, and soil, natural openings represent a huge wellbeing risk in Chhattisgarh. Because of fast populace development, industrialization, and urbanization, the state faces various natural wellbeing gambles.

In Chhattisgarh, air contamination is one of the vitally natural wellbeing gambles. A portion of the toxins that affect the state's air quality are PM2.5, PM10, and nitrogen dioxide. These pollutions can cause respiratory and cardiovascular contamination, as well as infection. Discharges from production lines and vehicles likewise affect the state's air quality. Also, the state's significant wellspring of air contamination is the consuming of yield deposits and wood. Chhattisgarh's water contamination is one more significant gamble to human wellbeing from the climate. Untreated modern effluents, sewage, and agrarian spillover all add to the state's high water contamination level. Cholera, typhoid, and loose bowels are water-borne ailments that can be welcomed on by these toxins. Weighty metals like lead, arsenic, and mercury are additionally present in the state's drinking water, which can cause serious medical problems.

Heavy metals	**Sources**
Chromium	Chrome plating, electroplating industry, leather training
Nickel	Galvanization, fertilizers, paint and powder
Lead	Pesticides, Petrol based materials, Leaded gasoline, mobile batteries
Copper	Electroplating industry, metal refining and industrial emission
Zinc	Rubber industries, Phosphate fertilizers, Batteries, Detergents

Table:2 Anthropogenic sources of some toxic heavy metals (Okoye et al.2022)

In Chhattisgarh, soil defilement is one more critical gamble to human wellbeing from the climate. The state has a raised level of soil contamination in light of current and country works out. Poisonous synthetics can bioaccumulation in the dirt, which can prompt medical problems like malignant growth and conceptive issues. Chhattisgarh faces various social and financial wellbeing gambles notwithstanding ecological wellbeing gambles. These incorporate unhealthiness, deficient disinfection and cleanliness, destitution, and unavailability to medical care. Intestinal sickness and dengue fever are two instances of transferable illnesses that can be spread by these variables. To reduce the danger to human wellbeing presented by natural openings in Chhattisgarh, an extensive methodology is fundamental (Joshi et al.202). This should consolidate predominant normal noticing, stricter necessity of biological rules, and public care campaigns. Admittance to clean drinking water, legitimate disinfection, and satisfactory sustenance for the populace is likewise essential.

VI. Conclusions and Recommendations

Summary of key findings

Furthermore, the examination of the prosperity risk evaluation uncovered that the bet of antagonistic prosperity influences from the focused on profound metals is high, especially for soil ingestion and dermal contact. Thus, it is proposed that extra exploration be done to determine the wellsprings of the weighty metal tainting and to assess likely systems for moderating the gamble to human wellbeing.

Suggestions for decreasing human openness to weighty metals in Chhattisgarh include: • Illuminating general society about weighty metals' sources and wellbeing impacts.

- Watch out for and cut down on the homegrown, modern, and agrarian wellsprings of weighty metals.
- Set rules and principles for water quality and discharges of weighty metals.

- Energize the utilization of sustainable power sources like breeze and sun oriented to eliminate air contamination.
- To eliminate emanations from modern sources, empower the utilization of innovations like electrostatic precipitators.
- Lay out water treatment offices to eliminate weighty metals from surface and groundwater.
- Engage the usage of soil modifications and manures that are low in profound metals.
- To protect networks from openness, make cushion zones around modern destinations.
- Make and authorize regulations that control how risky materials are utilized and discarded.
- While working with dangerous materials, energize the utilization of defensive attire and gear like respirators.

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