Assessing Heavy Metal Contamination Risk In Soil And Water Of Kanker District Of Chhattisgarh, India

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Abstract

Heavy metal in soil and groundwater, which can have a substantial impact on living organisms due to growth in industry and commercialization, is one of researchers' main concerns regarding the environment. In the current study, 10 samples of soil and water were collected from various locations in the Kanker district of Chhattisgarh, India to assess the degree of metal contamination for Pb, Cd, Ni, Cr, Cu, and As. Metal contamination levels were calculated using an atomic absorption spectrometer. The average concentration of all the metals in soil and water was below the permissible levels defined by the European Community (EU), WHO, and USEPA, which is 50-140 mg/kg in soil. In adults, the Average daily dose of soil was identified in the following sequence ADD_{ing}> ADD_{derm} >ADD_{inh}, whereas a similar pattern was observed for water: ADD_{ing}> ADD_{derm}. According to the health risk assessment, the overall Hazard Quotient and Hazard Index values were less than 1, indicating that there was a non-carcinogenic risk to individuals through all three routes of exposure to soil and water. For the carcinogenic risk in Kanker District agricultural soil that is greater than the permissible limit, or 10^{-6}–10^{-4}. It illustrates that the significant cancer risk caused by these heavy metals in the study region's soil. The goal of this study was to help through assessing different pollution indices for scientific administration for commercial operations towards environmental pollution its connection to ecosystems and human wellness.

Keywords: Heavy metal pollution, Soil and water, Health risk assessment

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1. Introduction

The significance of toxicity assessment in identifying risk to human health has increased recently. Because these elements are persistent, do not naturally degrade, and are even at relatively low concentrations, pollution from them has increased across the world. When permissible quantities are increased become detrimental such as Cd, Pb, and Cr and several toxic metals that also serve as basic and enzymatic constituents of proteins and catalysts and are necessary for cellular functions of the human body. They consist of Zn, Cu, and Ni [20, 21]. Actually, ingesting soil particles, drinking polluted water, or eating contaminated food can increase a person's absorption of heavy metal ions. Research has shown that, aside from chemical hazards, food intake via polluted foodstuffs is the primary pathway for humans to ingest heavy metals [8]. None the less, the presence of heavy metals in potable water in particularly in highly polluted localities, such as mining regions and metal industries, has a major impact on health beings [9,24]. It is difficult to neglect the intestinal bioavailability of soil-borne heavy metals, which could be dangerous for human health [18]. According to its adaptability, collection, non-biodegradability, and tenacity, heavy metal contamination poses a considerable global impact.

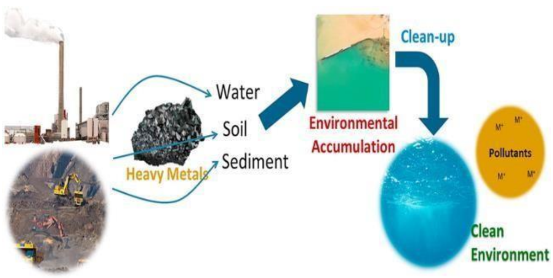

Fig.1. Schematic representation of heavy metal emissions its accumulation in environment

Soils are usually considered as a discharging medium for the detoxification of heavy metals. As a result, toxic metals have a tendency to move through waterways or accumulate in vegetation, which can then affect the pathway of food. Excessive amounts of contaminants in soil can degrade the production of agriculture by decreasing the condition of the soil, reducing the production of crops, and adversely affecting the health of people, animals, and ecosystems [22].Metallic elements accumulate in topsoil over time, that can result in a depletion of essential nutrients and the decline of the biological diversity in the soil. Excessive of concentration metals in soil serve substantial risks to the humans as well as animals [15]. Cancer, liver issues, neurologic, hematologic, endocrine system and reproductive abnormalities, as well as failure of the kidneys are significant health impacts connected with consumption to these potentially dangerous metals individually or in combination [3]. Through evaporation or infiltration form soil into groundwater, pollutants may be transported into drinking water. Limitations for water-related resources are influenced by degradation in quality brought due to contamination from human activity, industrial effluents, mining acid drainage, and diffused agricultural chemicals (pesticides, fertilisers, and herbicides). The primary supply of water in an urban environment, groundwater is used for home, manufacturing, and domestic purposes. However, because of increasing population and improper use, groundwater is typically overwhelmed [22].

Additionally, such dangerous heavy metals may reach the human body via contact by the skin with polluted water as well as by drinking of polluted water along with aquatic animals. Although prolonged absorption can also result in fatal diseases like Parkinson's, multiple sclerosis, Alzheimer's, and Cancer to such toxic metals may also cause physical, muscular, and mental disorders[4].For the betterment of the ecosystem and individuals, it is essential for precisely analysing the purity of surface water and the consequences of excessive metal contamination[28,31].Arsenic in Drinking water is the primary source by which an organism is exposed to arsenic, and it has emerged as a global problem. Acute health issues brought on by prolonged arsenic exposure include central nervous system damage, kidney damage, liver and failure of lungs, and dermal infection. Consuming arsenic-contaminated water on a regular basis can also lead to vascular diseases like hypertension and have an impact on the skin's colour. If Cd found in excessive amounts, it may harm the human body immunological system and causes respiratory a type of cancer, prostate proliferation tumours, kidney damage, osteotoxicity, damage to the liver. Amongst all toxic metals, chromium is one of the dangerous toxins that are detrimental to a living thing, cancerous to humans, and non-biodegradable. Ingestion of Ni can cause dry cough, difficulty in breathing, uneasiness, diarrhoea, skin rash, respiratory failure, intestinal pain, renal enema, and other adverse effects. A larger amount leads to kidney illness, cancers, mental illness, and adverse effects on the nervous system in people. Plants and animals are more at risk when lead is present. Too much Pb in bloodstreams can cause high blood pressure, damage the immune, hormonal, and skeletal systems lower an infant's memory, and damage kidney and heart function in individuals [12]. Because of the metal's persistent harmful effects, accumulation, and non-biodegradability, the presence of heavy metals of water and soil is now recognised as one of the world's severe environmental as well as health issues [13].

The objective of our research is to utilise an atomic absorption spectrometer to measure the amount of six toxic metals, including arsenic, copper, lead, cadmium, chromium and nickel in both soil and groundwater. In order to determine the extent of the above metallic pollution in the groundwater and soil in the Kanker region of Chhattisgarh, India, the goal of this research was to quantify it. The non-carcinogenic hazard quotient, carcinogenic risk and average daily dose variables coefficients were evaluate the risk to the health of humans because information on these elements is also necessary for studying this. As this area of study as we are aware, no earlier analysis has been done to estimate the presence of contaminants such as heavy metals in soil and water .In order to determine the potential adverse effects of these metals on human health and ecosystems, ten distinct regions were selected to analyse the concentration of metals that are present in soil and water. The results of the calculations provide appropriate data on the amount of pollutants and their effects on human health in relation to routines like consumption of vegetable and dermal adsorption through water [6].

Table 1 Permissible limits of different heavy metals in agricultural soil [32].

Heavy Metal	Limit concentration/mg kg−1 dw[a]				
	Agricultural soil EU, Current value[b] (soil pH: 6 ≤ pH < 7)	EU, Proposal[c] (soil pH: 6 ≤ pH < 7) <	Canad[d]	Sediment USA guideline[e,f]	Canada[g,h]
As	-	-	12	33	5.9
Cd	1-3	1	1.4	4.98	0.6
Cr	-	75	64	111	37.3
Cu	50-140	50	63	149	35.7
Pb	50-300	70	70	128	35.0
Hg	1-1.5	0.5	6.6	1.06	0.170
Ni	30-75	50	45	48.6	-
Zn	150-300	150	200	459	123.0

[a] Dry weight.

[b] Council of the European Communities (1986)

[c] Gawlik and Bidoglio (2006)

[d] Canadian Council of Ministers of the Environment (1999a)

[e] Ingersoll et al. (2000); National Oceanic and Atmospheric Administration's Office of Response and Restoration (2008)

[f] Consensus-based probable effect level.

[g] Canadian Council of Ministers of the Environment (2001)

[h] Canadian Interim Sediment Quality Guideline.

Table 2 Maximum concentration level for heavy metals in drinking-water and their toxicity [32]

Heavy Metal	MCL in drinking water/µg L−1					Toxicity/mg kg−1 bw[a]	
	WHO[b]	EU[c]	USA[d]	Canada[e]	China[f]	PTWI[g]	LD50[h]
As	10	10	10	10	10	Withdrawn (0.0021 daily)	41.0[l]
Cd	3	5	5	5	5	0.025 monthly	5.2[m] 88.0[i]
Cr	50	50	100	50	50[j]	-	-
Cu	2000	2000	1300	-	1000	0.500 daily[k]	5.6[m] 584.0
Pb	10	10	15	10	10	Withdrawn (0.025)	-
Hg	6	1	2	1	-	0.004	6.6 1.0
Ni	7	20	-	-	20	-	-
Zn	-	-	-	-	1000	1.0 daily[k]	20.2[m]

[a]Bodyweight.

[b]World Health Organization (2017)

[c]Council of the European Union (1998)

[d]United States Environmental Protection Agency (2018)

[e]Water and Air Quality Bureau - Healthy Environments and Consumer Safety Branch (2017)

[f]Ministry of Health of China (2006)

[g]Provisional tolerable weekly intake for humans JECFA (2017)

[h]Median lethal dose values obtained in mice or rats.

[i]Former value.

[j] Reported as hexavalent chromium.

[k]Maximum tolerable intake.

[l]Hunt et al., 2012.

[m]Jones et al., 1979

2. Materials and methods

2.1 General Description of Experimental Site

Kanker District (Fig 2) is situated in the southern region of Chhattisgarh, India in the longitudes 20.6-20.24 and latitudes 80.48-eighty one.48. The total area of district is 5285.01 square kilometres. The total population is 748,941.Red soil dominates the area's topography. In November and December, soil samples and water were taken for analysis. The ground water especially takes place in phreatic (water desk) situations and at places below semi-limited situations. The ground water sources for Kanker district has been expected primarily based on the Groundwater Estimation methodology 1997 technique.

2.2 Digestion of soil sample

Dry homogenized samples were weighed in a Teflon digestion vessel between 0.1 and 0.2 g. For microwave digestion of the samples, 5 mL of ultra-pure, highly concentrated nitric acid

(HNO3) and 2 mL of ultra-pure HCL, highly concentrated hydrofluoric acid (HF) were utilized. For 20 minutes Samples were processed and cooled for half an hour then samples was removed from the microwave, temperature of microwave was below 500^{o}C. After digestion if the residue remains in solutions then add1 mL HNO3 and repeat the process till clear solution appears. Than Teflon vessel taken out from microwave pour the sample solution in Teflon beaker and vessel is ringe with distilled water (about 3 ml).Teflon vessel heated with the help of hotplate (temp. 60^{o}C to 70^{o}C) till dry and beaker is washed with distilled water(15 ml). After that solution is filtered by using diameter 125mm, 100 circles filter paper and then added up to volume (either 30 or 50ml) with distilled water for analysis[6].

2.3 Digestion of water sample

All samples were accrued in sterilized acid-washed polyethylene terephthalate (PET) bottles and straight away transported to the laboratory. Before sample taking, all the bottles of sampling were soaked into 10 % solution of Nitric acid as well as were cleaned by rinsing in a metal-free soap. Metalloids consisting of As, Cr, Cu, Cd, Ni and Pb were analysed through AAS (Electronic Cooperation of India Limited) for both soil sample and water samples [6].

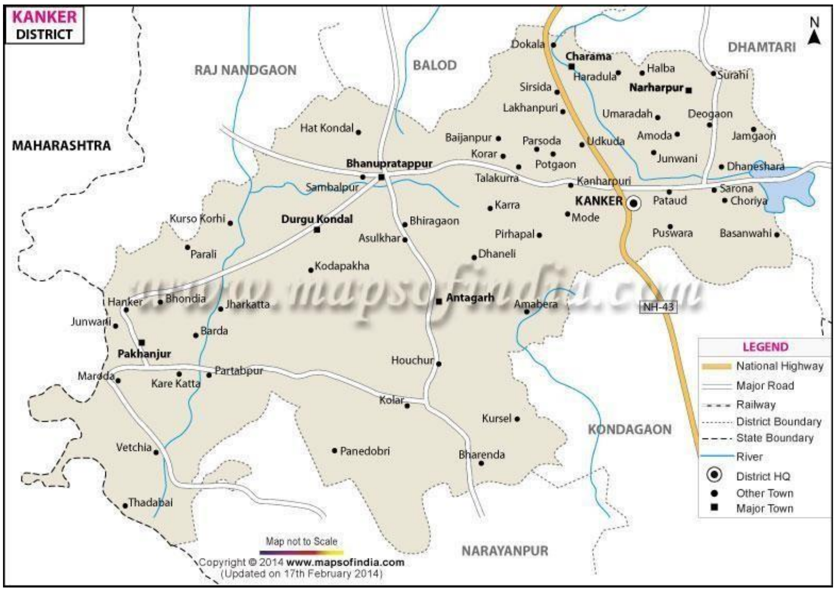

Fig. 2 Study area

3. Assessment of Health Risk

The average daily dose (ADD), non-carcinogenic target hazard quotient, hazard index, and lifetime carcinogenic risk variables were used to estimate the potential hazards associated with human being exposed to heavy metals in soil and water[10,26].

For non-carcinogenetic risk the ADD in mg kg^{-1}day^{-1} of doubtlessly poisonous toxic elements obtained via, inhalation, dermal and ingestion three different routes were calculated the usage of given formulation, Eq (2),(3) and (4) [17,1,11,23,,25,33,29,14,19,27]

$$\mathrm{ADD(ingestion)} = \frac{C \times IRing \times ED \times EF}{BW \times AT} \times CF \quad (2)$$

$$\mathrm{ADD(inhalation)} = \frac{C \times IRing \times ED \times EF}{BW \times AT \times PEF} \quad (3)$$

$$\mathrm{ADD(dermal)} = \frac{C \times SA \times SAF \times DAF \times ED \times EF}{BW \times AT} \times CF \quad (4)$$

Where, C = Heavy metal concentrations;
ABS= Dermal absorption factor (Unitless);
EF= Exposure frequency (in days/year);
IR=Ingestion rate;
EP= Exposure duration (in years);
BW= Body weight (in kg/person);
AT= Average time (in days);
SA= skin area available for contact (cm^2);
Kp= Permeability coefficient (in cm/hour);
CF= Unit conversion factor (in L = cm^3)

Table 3 Abbreviations and Input parameters for exposure assessment [30]

Input parameters	Units	Values	References
Pollutants Concentration in water	mg/l	See tables	This study
Ingestion rate (IR)	L/day	2.0	USEPA
Exposure time (ET)	min/day	35 min	Lee et al. (Lee et al., 2004)
Skin surface area (SA	m 2	1.8	USEPA
Exposure duration (ED)	year	30	Lee et al. (Lee et al., 2004)
Exposure Frequency (EF	days/year	350 days	Lee et al. (Lee et al., 2004)
Average lifetime (AT)	days	70 × 365	Pardakhti et al.(Pardakhti et al., 2011)
Body Weight (BW)	kg	70	Pardakhti et al.(Pardakhti et al., 2011)

Table 4 Reference dose (Rfd) for non carcinogenic heavy metal and slope factor for carcinogenic metal[2].

Heavy metal	RfD			SLOPE FACTOR		
	Ingestion	Inhalation	Dermal	Ingestion	Inhalation	Dermal
As	3.00E-40	1.23-04	1.23E-04	1.50E+00	4.30E-03	3.66E+00
Cr	3.00E-03	2.86-05	3.00E-03	5.01E-01	4.20E+01	2.00E+01
Cu	4.00E-02	4.00E-02	1.20E-02			
Cd	1.00E-03	1.00E-03	2.50E-05		6.30E+00	
Pb	1.40E-03	3.52E-03	5.24E-04	8.50E-03		
Ni	2.00E-02	2.06E-02	5.40E-03	1.70E0+00		4.25E+01

RfD Reference dose

The amount of each element in sample of soil and water (mg kg^{-1}) is shown by "C". Sum total of HQ give (HI). Total hazard index is of all three subjection routes with the help of HI non carcinogenic risk is assessed in human health. The fraction average daily dose (ADD) and its corresponding (RfD) reference dose gives hazard quotient[17].Hazard Quotient and Hazard Index both are calculated by way of the usage of the below Equations (5) and (6). [7, 17, 1, 11, 25, 29, 5]

$$HQ = \frac{ADD}{RfD} \quad (5)$$

$$HI = \sum HQi = \frac{\sum ADDi}{RfDi} \quad (6)$$

Where, HQ = Hazard Quotient; ADD = Average daily dose (mg/kg-day); RfD = Reference Dose (mg/kg-day). Reference Dose (Inhalation, Ingestion and Dermal) values for adults are calculated through USEPA 2010 (Integrated Risk Information System model). If the Hazard Index value exceeds than one, negative health consequences could result. However, if the numerical value of the Hazard Index does not exceed than one, people who are exposed will likely to be unaffected to have any obvious negative consequences on their overall health. According to the following formula, carcinogenetic health risks for a person caused by toxic elements over the duration of their lifetime are calculated by following equations (7) and (8) [17, 1,29, 5].

$$CR = ADD \times CSF \quad (7)$$

$$TCR = \sum CR \quad (8)$$

CSF = Cancer slope factor (mg/kg/day).

When the ranges of CR are more than 10^{-4}, it shows that there is risk of cancer in humans but the ranges not of CR are not greater than 10^{-6}, it means no risk of cancer [17].

4. Result and discussion

4.1Application to real samples

While samples of water were merely acidified to a pH of less than 2.0 using HNO3, the exact same acid method of extraction was used on samples of soil to extract Cr, , Cu, As, Cd, Ni, and Pb by using AAS. The results are shown in Table 5 of this study [6].The concentration of toxic metals in soil was determined in the following order, Pb>As>Ni>Cu>Cd>Cr whereas the amount found in water was observed in a sequence as follows: Pb>Cr>Ni shown in Fig 3 and 4.The mean value of Cr 0.25 mg kg^{-1} and 0.894 mg kg^{-1} was found to be within the acceptable range in both soil and water samples. Cu content in soil is 0.35 mg kg^{-1} were found to be within the WHO-recommended standard range (Cu: 2.0) but in water samples Cu is not detected. Despite copper is a vital nutrient, excessive amounts of it within the soil can be hazardous for certain vegetation and useful microbes, prevent the breakdown of the phosphate group and nitrogen-containing compounds, have adverse impacts on the health of humans, and become poisonous for animals such as fish and other types of aquatic life.

As in soil were not exceeded by the mean concentration of 0.94 mg kg^{-1}, which was found in soil with in permissible level. However, not detected in water samples. The quantity of As in the soil and how it affects plants is correlated linearly, and irrigation with water and cultivation in As-contaminated soil have a negative impact on growth and yield. The standard limit for Cd in soil, which is 0.13 mg kg^{-1}, was determined to be but in water samples it has been not detected. The adverse effects of the excessive levels of cadmium on beneficial microorganisms disrupt their metabolism and prevent their growth. In human beings, cadmium has a long biological half-life (10–35 years).In case of Pb its mean concentration in soil and water samples was 2.46 mg kg^{-1} and 1.26 mg kg^{-1} respectively, and was below the standard limit established by regulatory organisations .The greater Pb content of soil has a negative impact on the quantity of carbon and nitrogen-containing microbiological biomass and lowers productivity by slowing down the process of nutrient cycling. Pb is more uncommon in natural sources than it is from man-made sources, thus its presence in the surroundings is regarded as an indication of pollution. The average Ni concentrations found in soil and water samples was 0.86 mg kg^{-1} and 0.665 mg kg^{-1} respectively and was confirmed to be below the standard limit. The main causes of nickel pollution in water are the electrolysis and nickel extraction industries, as well as the combustion of petroleum and other fossil fuels. A high concentration of Ni might also cause microorganisms to experience a reduction in metabolism. According to the results, the amount of nickel concentrations found in the samples had been within acceptable ranges [16].

Table 5 The amounts of toxic metals (mg kg^{-1}) in soil and water Kanker District of Chhattisgarh (n=10) soil and water

Samples	Cu (soil/water)	Pb (soil/water)	Ni(soil/water)	Cr (soil/water)	Cd (soil/water)	As (soil/water)
S1	0.14	2.2/1.1	0.86/0.33	0.184/0.88	0.056/Not Detectable	0.172/Not detectable
S2	0.332	1.2/3.6	0.934/0.46	0.274/011	0.068/Not Detectable	1.561/Not detectable
S3	0.12	2.08/1	0.53/0.42	0.178/2.63	0.024/Not Detectable	0.12/Not detectable
S4	0.08	2.54/1.1	0.888/0.5	0.362/Not Detectable	0.16/Not Detectable	Not detectable
S5	0.084	2.92/1	0.866/0.95	0.378/0.47	0.14/Not Detectable	0.011/Not detectable
S6	0.75	3.86/0.8	1.106/1.07	0.194/0.38	0.026/Not Detectable	1.6/Not detectable
S7	0.614	3.18/1.2	0.672/0.81	0.16/Not Detectable	0.32/Not Detectable	1.5/Not detectable
S8	0.18	1.89/0.9	0.77/0.78	0.172/Not Detectable	0.036/Not Detectable	0.153/Not detectable
S9	0.56	1.78/1.1	0.93/066	0.254/Not Detectable	0.46/Not Detectable	1.71/Not detectable
S10	0.64	3.26/0.8	1.08/0.67	0.335/Not Detectable	0.052/Not Detectable	1.63/Not detectable
Mean	0.36	0.13/1.26	0.35/0.665	0.25/0.894	0.86	0.94
Max	0.75	0.46/3.6	0.75/1.07	0.378/2.63	1.106	1.71
Min	0.08	0.024/0.8	0.08/0.33	0.16/0.11	0.53	0.011

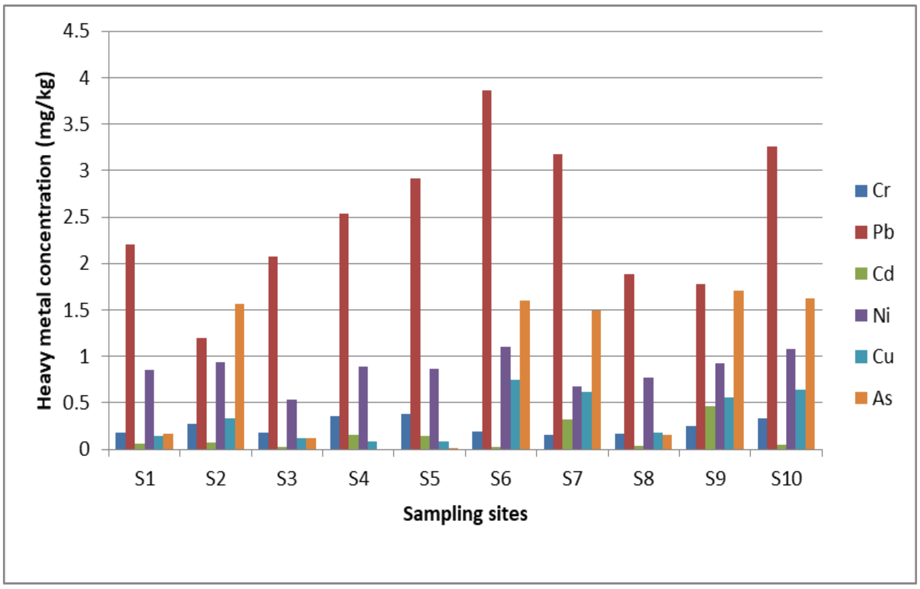

Fig. 3. Heavy metal concentration in soil samples of study area

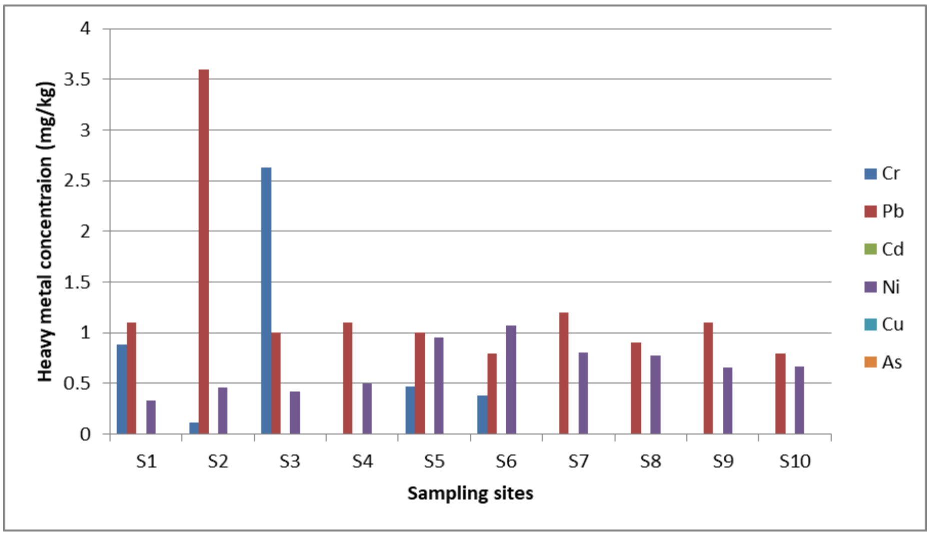

Fig. 4. Heavy metal concentration in water samples of study area

4.2 Assessment of human health risk

4.2.1 Average daily dose

For elements such as Cr, Cu, As, Cd, Ni, and Pb (Heavy Metals), Average daily dose in mg^{-1} kg^{-1} day^{-1} was estimated using three exposure pathways: ADD_{ing}, ADD_{inh}, and ADD_{derm} for soil; ADD_{ing} and ADD_{derm} for water. Adults' ADD conditions for soil were identified in the following order: ADD_{derm} > ADD_{ing} > ADD_{inh}, whereas adults' ADD conditions for water were found in the following order: ADD_{ing} > ADD_{derm}. Accordingly (Pb>Cr>Ni) Pb, followed by Cr, and then Ni, made up the average daily intake of metalloids in water for people. The results revealed that the adults are more exposed to the heavy metals of soil as compared to the water samples.

4.2.2 Total hazard quotient (HQ) and Hazard index (HI)

For soil and water samples for all metals, the HQ values is shown in (Table 6) in adults has been determined in the following order: HQ_{derm}>HQ_{ing}>HQ_{inh}. While the order of HQ_{ing}>HQ_{derm} for in water was observed in adults. For each metal, the Hazard Index values in adults were less than 1, indicating no major health risk from soil and water exposure. As a result,values shown in Table 7 shows that there was no significant risk to human health for all metals in soil and water, with an HI value is less than of 1.

Table 6 Average daily dose (ADD) and Hazard Quotient (HQ) values of adults in soil and water of research area

Metal Soil	ADD_{ing}	ADD_{inh}	ADD_{derm}	HQ_{Ing}	HQ_{Inh}	HQ_{Der}
Cr	4.44× 10-7	4.17 × 10-11	1.93× 10-5	1.48 × 10-4	1.46× 10-6	6.45 × 10-3
Pb	4.44× 10-7	4.17 × 10-11	1.50×10^{-9}	3.17×10^{-3}	1.18×10^{-7}	2.86×10^{-6}
Cd	2.39 × 10-7	2.25 × 10-11	1.04× 10-5	2.40 × 10-4	2.25 × 10-8	4.17 × 10-1
Ni	1.55 × 10-5	1.45 × 10-9	6.70× 10-4	7.71 × 10-4	7.02 × 10-8	1.24 × 10-1
Cu	6.25 × 10-7	5.86× 10-11	2.71× 10-5	1.56× 10-5	1.47× 10-9	2.27 × 10-3
As	1.68 × 10-6	1.57 × 10-10	7.30 × 10-5	5.59 × 10-3	1.28× 10-6	5.93 × 10-1
Water						
Cr	2.4 × 10-5	-	1.1 × 10-7	9.37×10^{-6}	-	7.31×10^{-6}
Pb	3.96 × 10-5	-	7.72 × 10-8	2.83×10^{-5}	-	1.84×10^{-7}
Cd	-	-	-	-	-	-
Ni	2.09 × 10-5	-	8.15 × 10-9	1.05×10^{-6}	-	1.51×10^{-9}
Cu	-	-	-	-	-	-
As	-	-	-	-	-	-

ADD_{ing} Average daily dose $_{inhalation}$
ADD_{derm} Average daily dose $_{dermal}$
ADD_{inh} Average daily dose $_{inhalation}$
HQ_{ing} Hazard Quotient $_{ingestion}$
HQ_{derm} Hazard Quotient $_{dermal}$
HQinh =Hazard Quotient inhalation

5. Assessment of Carcinogenic risk

A lifetime exposure to heavy metals (Cr, Cu, As, Cd, Pb, and Ni) through various exposure routes, such as ingestion, inhalation, and skin contact, was evaluated using the carcinogenic slope factor. According to the Lifetime Cancer Risk magnitude there is no carcinogenic risk, a high risk of developing cancer, and an acceptable level of risk for humans, respectively (LCR=$10^{-6,}$ LCR=$1x10^{-4}$, and LCR=$1x10^{-6}$ to $1x10^{-4}$).Pb, Cd, Cu, As, Cr, and Ni were the six elements with the Lifetime Cancer Risk values (LCR) for people in this research area shown in Table 7and the LCR values is less than permissible limit in water. The ingestion route is the primary way to acquiring Lifetime Cancer Risk followed by dermal and inhalation pathways.

Table 7. Hazard Index and Lifetime Cancer Risk values from soil and water for adults

Metal Soil	HI	Interpretation	LCR	Interpretation
Cr	6.60×10-3	No Significant risk	3.87 × 10-4	Significant risk
Pb	3.18×10^{-3}	No Significant risk	3.93× 10-8	No significant risk
Cd	4.17×10^{-1}	No Significant risk	1.06 × 10-5	Significant risk
Ni	1.25×10^{-2}	No Significant risk	2.85 × 10-3	Significant risk
Cu	4.28×10^{-5}	No Significant risk	2.78× 10-5	Significant risk
As	7.47×10^{-5}	No Significant risk	2.69 × 10-4	Significant risk
Water Metal				
Cr	1.67 × 10-5	No Significant risk	1.62 × 10-5	No Significant risk
Pb	2.85 × 10-5	No Significant risk	3.37 × 10-4	No Significant risk
Cd	-	-	-	-
Ni	1.05 × 10-6	No Significant risk	1.75 × 10-5	No Significant risk
Cu	-	-	-	-
As	-	-	-	-

HI Hazard Index
LCR Lifetime Cancer Risk

6. Conclusion

The primary objective of the current study was to evaluate the significant health risks associated with consuming the fruits and vegetables grown in this region as well as drinking the ground water. A total of ten samples of water and soil were collected from various locations in the Kanker district of Chhattisgarh, India, to assess the pollution level of Pb, Cd, Ni, Cr, Cu, and As. At various locations around the area, the average amounts of Cr, Pb, Cd, Ni, Cu, and As in soil samples were found to be 0.25±0.084, 2.49±0.81, 0.13±0.14, 0.86±0.17, 0.35±0.26, 0.94±0.79 mg/kg respectively at different sampling area. While their content in water was found in the following order: Pb>Cr>Ni while arsenic, cadmium, and copper were not detected, the highest value of lead was determined, i.e., 3.86±0.11 mg/kg (site 6), that followed by arsenic, i.e., 1.71±0.087 mg/kg (site 9). The average concentration of all elements was determined to be within the standard limit established by regulatory organisations such the WHO, EPA, and EU in both soil and water samples (n=10, each). The extent of metal contamination in soil results in individuals in a position of low-to-borderline cancer risk through being exposed to heavy metals based on the outcomes of human health evaluations. To decrease the probability of the heavy metal contamination of soil and water, nevertheless, this necessary of public awareness and cooperation. Due to contaminants may bio-accumulate, these potentially dangerous toxic components must be substantially decreased in soil as well as water. As a result, our studies can assist with precautionary actions for ensuring urban ecosystem.

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