IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 19, Issue 3 Ser. I (March. 2026), PP 12-16
www.iosrjournals.org

Heavy Metal Concentrations In The Ground Water Of Raigarh District, Chhattisgarh

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Abstract:
Ground water poisoning, global climate change, industrial waste, and other factors have all contributed to new environmental issues in recent years, drawing attention to the need to preserve the environment. In appropriate industrial effluent discharge is one of the main causes of ground water contamination. These effluents contain a great deal of heavy metals, which have negative impacts on human health .The current investigation on ground water contamination caused by heavy metals in and around Raigarh district. Groundwater samples were collected from different location of Raigarh district during pre monsoon, and post monsoon (2021 to 2022) respectively. Ground water Samples were collected and analyzed for heavy metals such as chromium, cadmium, cobalt, arsenic, lead and mercury using Atomic Absorption Spectrophotometer (AAS). The analytical data was compared with the guidelines prescribed by WHO. The finding indicates that lead concentrations in some sources of ground water exceeded the permissible limit and that other metals were within the permissible limit in all sources. The heavy metal contamination may due to the discharge of waste, industrial and municipal wastewater, disposal of solid waste by land filling and other anthropogenic influences in this region.
Keywords: *Heavy Metals, Ground Water, Atomic Absorption Spectrometer (AAS).*

Date of Submission: 27-02-2026 Date of Acceptance: 07-03-2026

I. Introduction:

Water is essential for home, industrial, and agricultural uses everywhere in the world. However, population growth, industry, and urbanization all contribute to groundwater contamination. Restoring the contaminated groundwater is difficult. Therefore, it is important to preserve the quality of groundwater. 80% of infections, according to the WHO, are caused by contaminated ground water[1]. The quality of the ground water will decline as it moves from the recharge area to the discharge area due to chemical interactions [2].One of the main pollutants in groundwater sources is heavy metals[3]. Some of these heavy metals are necessary for an organism's growth, development, and health, while others are not since they are irreplaceable and the majority of them are poisonous to living things[4].There are more than 50 elements that fall under the category of heavy metals, and 17 of them are known to be both highly hazardous and easily accessible[5].

A "heavy metal" is any metallic element that has a relatively high density and is poisonous or harmful even at low concentrations[6]. The term "heavy metals" is used to describe a group of metals and metalloids that have a higher atomic density compared to water. Specifically, these metals and metalloids have a density that is equal to or greater than 4 grams per cubic centimeter (g/cm3), which is at least five times denser than water [7]. Certain heavy metals have essential roles in biological systems as trace elements, meaning they are required in small amounts for proper functioning. However, the toxic effects of many heavy metals on human biochemistry are a significant concern[8]. It is crucial to understand the conditions under which these metals become harmful, including their concentrations and oxidation states, as well as how bio toxicity occurs.

The focus of this study is the heavy metal analysis of groundwater in Raigarh district. The collected data was then compared to the standard values recommended by the World Health Organization (WHO) and the IS-10500-2012 drinking water guidelines.

Study area: -

The Raigarh district, the Sanskardhani capital of Chhattisgarh, is renowned for its coal reserves and electricity production for both the state and the nation. It is well-known for its kosa or tasar, a type of exquisite silk produced by the silkworm eating on mulberry fruit. (According to the 2011 Census) The district of Raigarh is located in Chhattisgarhs northeastern region. It is divided into 6 tehsils and 9 blocks and is located between the latitudes of 21°20' 21" and 22°47'13" N and the longitudes of 82°55'36" and 83°42'16" E. There are 1485 villages there.

Table: -01 Sampling Stations and their sources

S.N.	Sampling Station	Sample Name	Source Type	Sampling Location
1.	Atarmuda	R-1	B.W.	Govt. Poultryfarm atarmuda Raigarh (C.G.)
2.	Bhagwanpur	R-2	H.P.	Near Primary School bhagwanpur Raigarh (C.G.)
3.	Boirdadar	R-3	B.W.	KVK Krisivigyan Kendra Raigarh (C.G.)
4.	Chhotemudpar	R-4	B.W.	Near Aklavya School Kharsiya Distt.- Raigarh (C.G.)
5.	Farkanara	R-5	B.W.	Near H.S. School Farkanara Kharsiya Distt.- Raigarh (C.G.)
6.	Kirodimal	R-6	B.W.	Ajad Chouk Kirodimal Nagar Raigarh (C.G.)
7.	Kevdabadi	R-7	B.W.	Pashu chikitsalaya Kevdabadi Raigarh (C.G.)
8.	Kukrijhariya	R-8	B.W.	Near Primary School Kukrijhariya Raigarh (C.G.)
9.	Nawarangpur	R-9	H.P.	Near School Nawarangpur Raigarh (C.G.)
10.	Patrapali	R-10	B.W.	Pashu aushadhalay Patrapali Raigarh (C.G.)

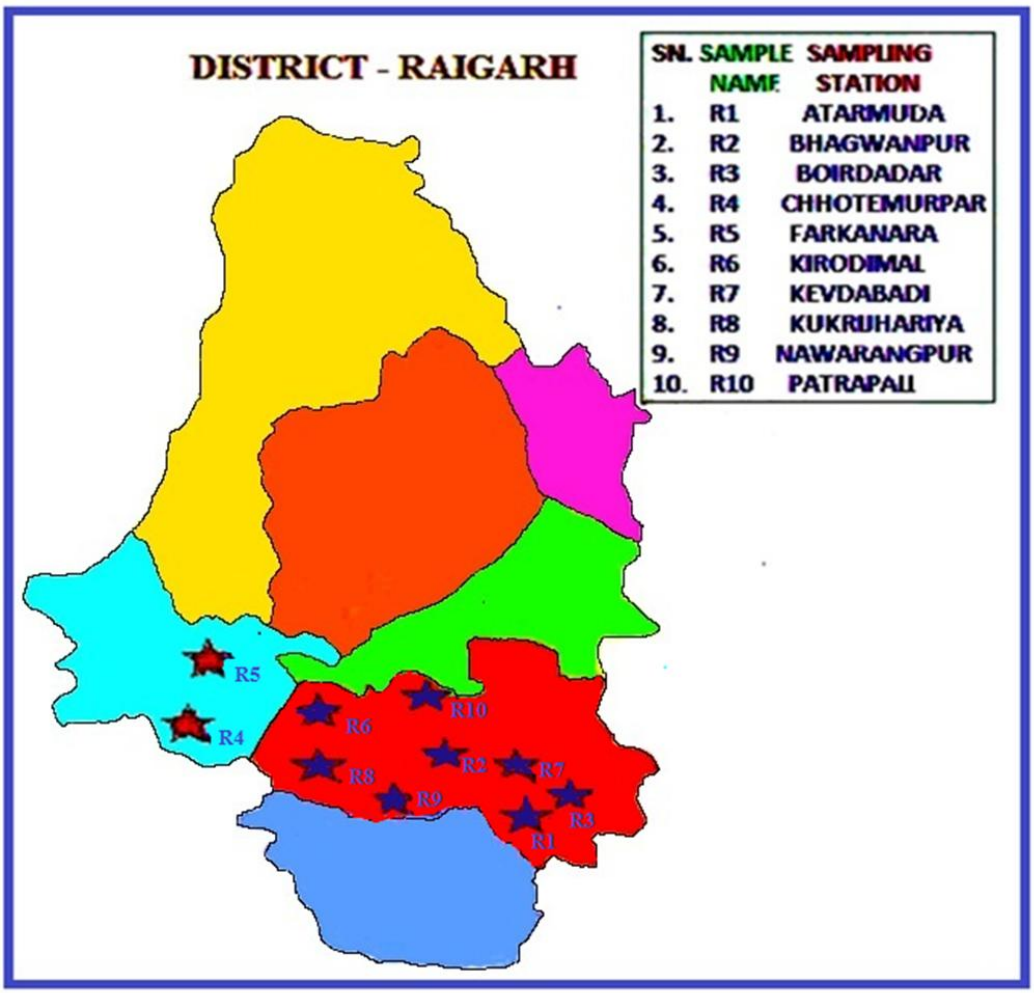

Figure 1: Map of Raigarh District with sample locations marked.

II. Methods And Materials

The water samples were collected from ten sampling stations. To capture seasonal variations, samples were collected both during the pre-monsoon and post-monsoon seasons for two consecutive years (2021 and 2022). The samples were collected from bore well and hand pump (both agricultural and household) after a free-flowing period of 10-15 minutes before being filled into pre-cleaned high-density polyethene (HDPE) bottles. Water samples acidified to pH 2 with conc. HNO_3 on collection sites, transport to laboratory and then stored in refrigerator at approximately 4 to prevent change in volume due to evaporation. The analysis of trace metals was carried out with the help of AAS (Atomic Absorption Spectrometry). AAS is well known and reliable technique; it is preferred method of element analysis. In this method, a light beam passes through a flame and then into a monochromator, ultimately reaching a detector that gauges the light absorption by the atomized element in the flame. AAS stands out in sensitivity since each metal possesses a unique absorption wavelength. The energy absorbed at this specific wavelength in the flame directly corresponds to the element's concentration in the sample.

III. Results & Discussion:

The current study examined the variations in heavy metal concentrations in 10 drinking water samples between the pre-monsoon and post-monsoon periods (2021-2022). The observed levels for each metal were compared to the normative values established by the World Health Organization (WHO). The results of heavy metal analysis in ground water samples were collated in a table and presented using graphical diagrams.

Table 1: Heavy metal analysis results during pre-monsoon 2021

S.N.	Metals	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	min.	max.	Average	WHO Standard
1	As	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.01
2	Cd	BDL	BDL	0.001	BDL	BDL	0.001	BDL	BDL	BDL	BDL	0.001	0.0014	0.0012	0.003
3	Cr	0.02	0.03	0.01	0.01	0.02	0.03	0.017	0.05	0.01	0.023	0.01	0.05	0.0216	0.05
4	Co	BDL	BDL	0.01	BDL	BDL	0.04	BDL	0.02	0.01	BDL	0.01	0.04	0.02	-
5	Pb	0.03	0.03	0.02	BDL	BDL	0.01	0.048	0.05	0.04	0.085	0.01	0.085	0.03975	0.01
6	Hg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.001
Note-All Values are expressed in mg/l															

Table 2: Heavy metal analysis results during post-monsoon 2021

S.N.	Metals	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	min.	max.	Average	WHO Standard
1	As	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.01
2	Cd	BDL	BDL	0.0023	BDL	BDL	0.002	BDL	BDL	BDL	0.001	0.001	0.0023	0.00177	0.003
3	Cr	0.03	0.03	0.01	BDL	0.01	0.057	0.02	0.06	BDL	0.028	0.01	0.06	0.03063	0.05
4	Co	BDL	BDL	0.03	BDL	BDL	0.05	BDL	0.04	0.02	BDL	0.02	0.05	0.035	-
5	Pb	0.05	0.05	0.046	BDL	BDL	0.02	0.05	0.04	0.04	0.09	0.02	0.09	0.04763	0.01
6	Hg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.001
Note-All Values are expressed in mg/l															

Table 3: Heavy Metal Analysis results during pre- monsoon2022

S.N.	Metals	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	min.	max.	Average	WHO Standard
1	As	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.01
2	Cd	BDL	BDL	0.0018	BDL	BDL	0.001	BDL	BDL	BDL	0.001	0.001	0.0018	0.00133	0.003
3	Cr	0.02	0.03	0.01	BDL	0.01	0.04	0.02	0.05	0.02	0.03	0.01	0.05	0.02556	0.05
4	Co	BDL	BDL	0.01	BDL	BDL	0.032	BDL	0.022	0.003	BDL	0.003	0.032	0.01675	-
5	Pb	0.05	0.04	0.013	BDL	BDL	0.017	0.03	0.04	0.04	0.065	0.013	0.065	0.03613	0.01
6	Hg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.001
Note-All Values are expressed in mg/l															

Table 4: Heavy Metal Analysis results during post-monsoon 2022

S.N.	Metals	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	min.	max.	Average	WHO Standard
1	As	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.01
2	Cd	BDL	BDL	0.0025	BDL	BDL	BDL	BDL	BDL	BDL	0.003	0.003	0.003	0.0028	0.003
3	Cr	0.01	0.04	0.02	BDL	0.02	0.06	0.03	0.062	0.024	0.025	0.01	0.062	0.0333	0.05
4	Co	BDL	BDL	0.012	BDL	BDL	0.04	BDL	0.03	0.006	BDL	0.006	0.04	0.022	-
5	Pb	0.05	0.05	0.01	BDL	BDL	0.025	0.05	0.035	0.042	0.08	0.01	0.08	0.0424	0.01
6	Hg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-	-	0.001
Note-All Values are expressed in mg/l															

Arsenic: - Arsenic in groundwater is a serious concern due to its toxicity. It can occur naturally or result from human activities. Arsenic was not found in all examined sources in both seasons during the study period.

Cadmium: - Cadmium is a hazardous non-essential element. Cadmium was detected in three sources (R-3, R-6 and R-10), with all values under the WHO permissible limit of 0.003 mg/l. The highest concentration was in R-3 at 0.003 mg/l, while the lowest was in R-6 at 0.001 mg/l.

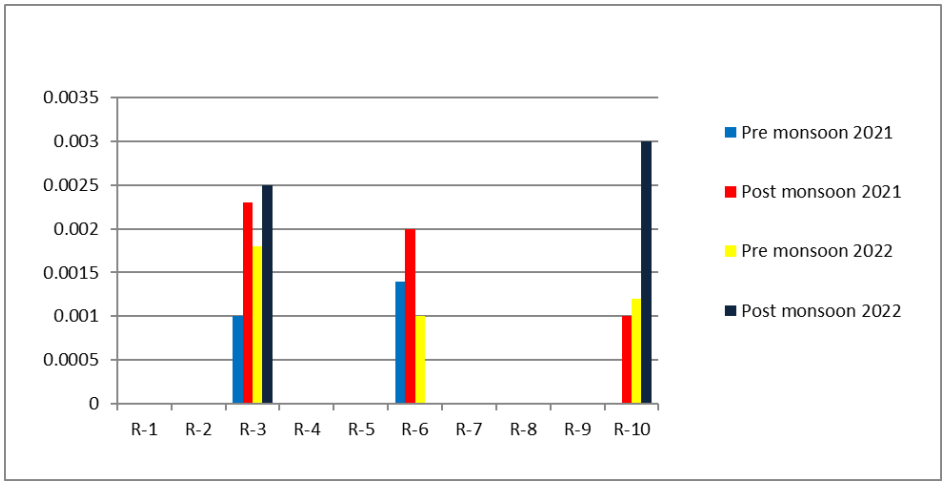

Figure 2: The variation of Cadmium in Raigarh district during pre-and post-monsoon (2021-2022)

Chromium: - The permissible Cr level in drinking water is defined as 0.05 mg/L by the WHO. The majority of sources in study area remain below this criterion. However, two sources (R-6 and R-8) during the post-monsoon period exceeded this limit. In the post-monsoon season of 2022, the highest chromium concentration of 0.062 mg/l was observed in the R-8 sampling station.

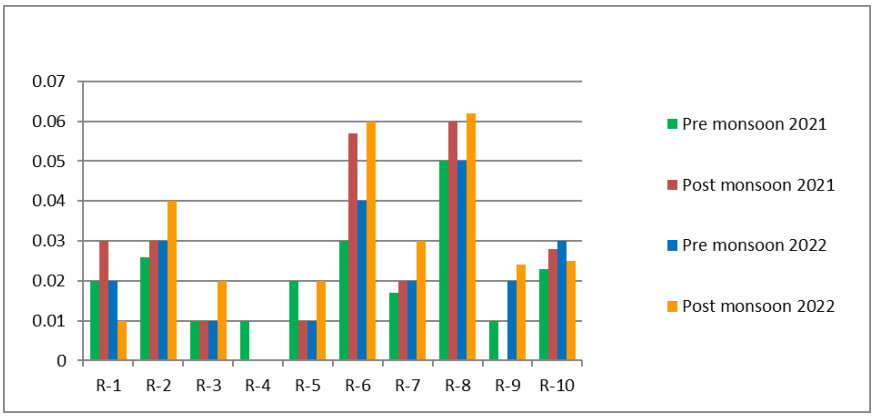

Figure 3: The variation of chromium in Raigarh district during pre-and post-monsoon (2021-2022)

Cobalt: - Cobalt is essential for humans and other mammals since it is a component of vitamin B_{12}. Cobalt, in higher concentrations, can be toxic to humans, land and water animals, and plants. Cobalt was detected at four sampling stations (R-3, R-6, R-8, and R-9), with concentrations within permissible limits.

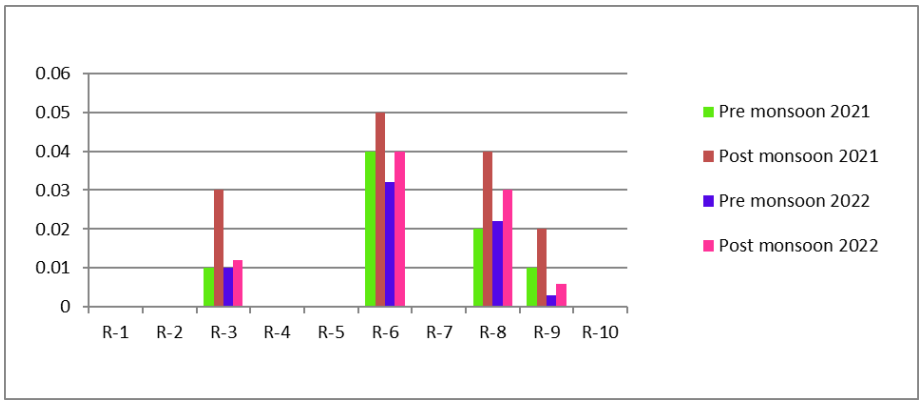

Figure 4: - The variation of Cobalt in Raigarh district during pre-and post-monsoon (2021-2022)

Lead: - Lead in groundwater is a significant concern as it poses health risks. The World Health Organization recommends a lead limit of 0.01mg/l. In the study area, the majority of sources showed lead levels surpassing the recommended values, except for two. The highest lead concentration, reaching 0.09 mg/l, was observed in

R-10 during the post-monsoon period of 2021. High concentrations of lead in ground water can result from various factors, including industrial discharges, agricultural runoff, and human activities, such as mining and improper waste disposal, can contribute to lead contamination.

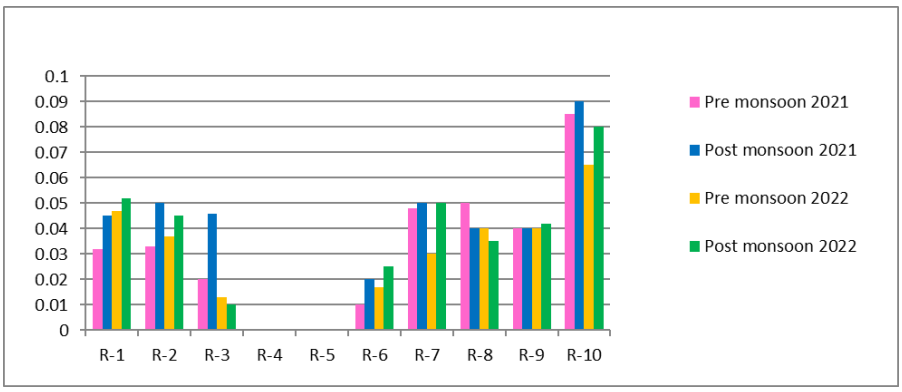

Figure 5: - The variation of Lead in Raigarh district during pre-and post-monsoon (2021-2022)

Mercury: - The statistics show that mercury was not identified in any water sources of study area.

IV. Conclusion:

The analysis of heavy metals in groundwater quality revealed concerning levels of lead exceeding permissible limits in the majority of sources. However, chromium, cadmium, and cobalt remained within acceptable boundaries. Notably, arsenic and mercury were not detected in the examined sources. The heavy metal contamination may due to the discharge of waste, industrial and municipal wastewater, disposal of solid waste by land filling and other anthropogenic influences in this region. Regular monitoring and addressing the sources of contamination are crucial for ensuring safe drinking water.

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