

Assessment of Uranium Pollution in Ground water and Human Health in Balod District, Chhattisgarh

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Abstract

A laser fluorimetric technique was used to measure the amount of uranium present in samples of groundwater from the Balod district, Chhattisgarh, central India. For this purpose, we collected twenty-nine water samples from different villages in the Balod district, Chhattisgarh from September 2022 to June 2023. Here, the concentration of uranium in the sample of water ranges from 0.10 to 66.7($\mu\text{g/l}$). A maximum number of samples had uranium contamination levels below the acceptable limit (30 $\mu\text{g/l}$), except for Siwani village (66.7 $\mu\text{g/l}$), as approved by the WHO. The USEPA recommendations were used to determine the chemical risk (Non-carcinogenic) and excess lifetime carcinogenic risk (ECR) caused by groundwater consumption. The allowed excess lifetime cancer risk (ELCR) value of $1.0 \cdot 10^{-4}$ was found to be exceeded in a few water samples by the risk of cancer resulting from drinking water. The LADD value of 18 % and HQ value of 24% of the water sample exceed the permissible limit indicating a high risk of chemical poisoning. In this analysis, we found that the area's uranium's chemical toxicity may be the cause of non-carcinogenic health problems, but eventually, there is no Carcinogenic (radiological) risk to people.



Article History

Received: 19 February 2024

Accepted: 27 June 2024

Keywords

Carcinogenic Risk;
Groundwater;
Hazard Quotient;
Laser Fluorimetric
Technique.

Introduction


A naturally occurring uranium contains a radioactive heavy metal that can be available in various geological formations. Its potential impacts on the environment and human health make it a reason for concern when it finds its way into groundwater. The World Health Organization gave a tolerable limit for uranium of 30 $\mu\text{g/l}$ in drinking water.² The naturally occurring radioactive metal uranium has a molar mass of 238.03 g/mol and an atomic number 92.

It emits alpha particles. Uranium is a very important element in the field of science and technology due to its both radiological and chemical characteristics.^{1,4} Because it exists in different quantities in water, rock, and air, it is an inevitable part of our environment³ Contamination of uranium in groundwater is caused by both natural and man-made sources, such as leaching from natural deposits, emissions from, burning coal and fuels, nuclear power stations, releases in mill tailings, and the use of fertilizers containing

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Doi: <https://dx.doi.org/10.12944/CWE.19.2.31>

phosphate.^{7,15} Chronic exposure to elevated uranium levels in drinking water can cause harm to the kidneys.⁹ It is well known that uranium toxicity develops in the kidneys, where it can eventually lead to a variety of kidney-related health problems.⁸ Uranium is considered a potential carcinogen. Long-term uranium exposure can raise the chance of developing several cancers, such as lung and liver tumours, as well as bone cancer, especially when the uranium is radioactive.⁵ Apart from cancer and kidney damage, uranium exposure has also been linked to non-cancer health effects such as developmental and neurological disorders, reproductive troubles, and cardiovascular issues.¹⁰ It is a highly toxic element. It causes serious disability due to radiation exposure, cancer risk, and renal damage from drinking water, so to protect against radiation damage and other various health problems due to uranium, it is monitored by the United States Environmental Protection Agency (USEPA)

and different Health Organizations. For uranium, the maximum Concentration Level was fixed by the EPA according to the Safe Drinking Water Act (SDWA).¹¹ According to the Agency for Toxic Substances and Disease Registry, radiological chemical risk is due to the contamination of uranium present in the underground water. when 0.1–6% of uranium is consumed by adults and absorbed in the blood.⁶ The concentration of various drinking water resources should be monitored for the purpose of decreasing the radioactive chemical health risk posed by uranium in groundwater. For the purpose of determining the health risk caused by consuming this water, the uranium contamination level in groundwater samples collected from the Balod district in Chhattisgarh, India, will be measured by laser-induced fluorimetry.

Materials and Methods

Study Area

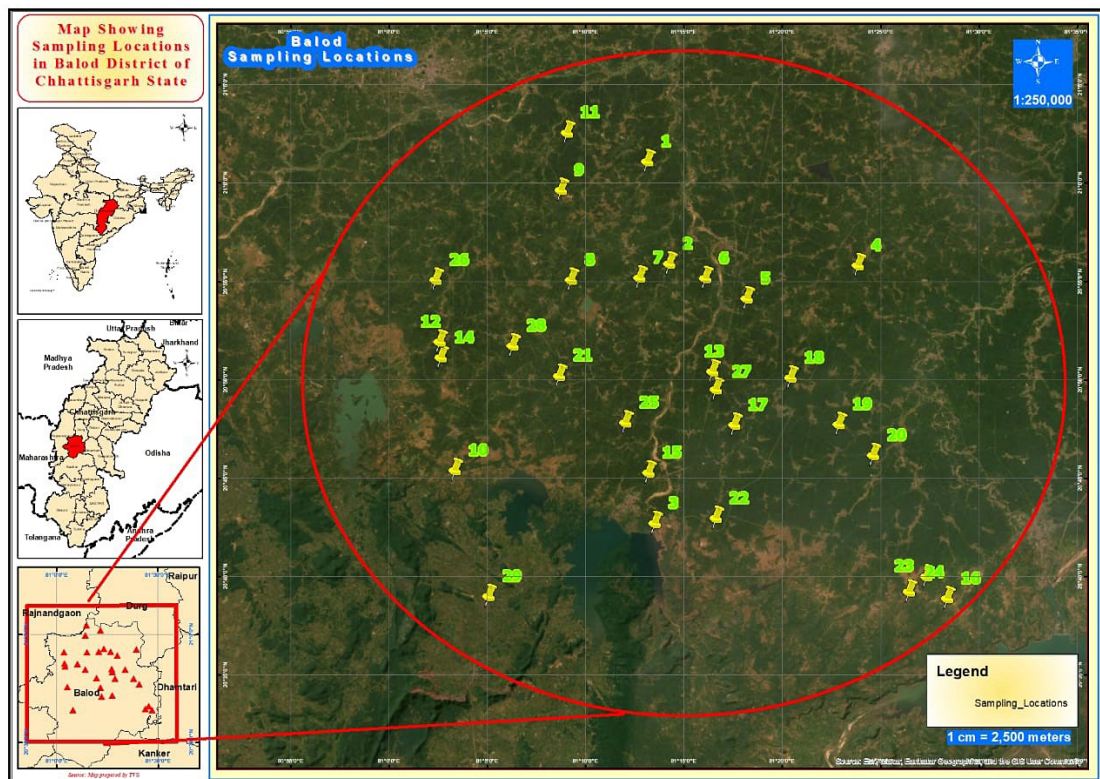


Fig. 1: Location of the research area in Balod district

Balod district is Located in the center of Chhattisgarh, Balod has unique features and rich mineral resources. It is situated between longitudes 80°48' and 81°30' east and latitudes 20°23' and 21°03' north. Balod is surrounded by five districts: in the north, Durg, which is famous for its industrial development center; in the south, Kanker, which is famous for its natural beauty, in the west, Rajnandgaon, which is known as the Sansakardhani; in the southwest, Mohla- Mnpur- Ambagarh -Chonki; and in the east, Dhamtari, which is known for medicinal properties. Area of Balod 3527 km².

Sample Collection and Preservation

Twenty-nine water samples were collected from September 2022 to June 2023 from open wells and closed wells at different locations in the research area. At the time of sampling, collect the sample using a clean plastic bottle that has been pre-washed with distilled water. To reduce the amount of uranium lost by absorption in the bottles, 0.2 milliliters of nitric acid were added to all the samples that were brought inside the lab. The date, location, and time of the sampling were indicated on the labels attached to the samples. An LED fluorimeter was used to analyze the amount of uranium contained in water samples.

Determination of Uranium in Sample of Water Laser-Induced Fluorimetry

The laser-induced fluorimetric technique is used to determine the quantity of uranium present in samples of water. The analysis of uranium is done by the LF-2a LED fluorimeter, which is made by Quantalase Enterprises Private Limited. Indore. The Quantalase LED Fluorimeter is a direct method for detecting and measuring uranium content in samples of water. Stimulate the fluorescence of uranium (VI) compound in the water sample when using a pulsed UV LED from the device. A photomultiplier tube (PMT) with high sensitivity can detect the green fluorescence that uranium complexes emit after excitation. The fluorescence yield indicates the quantity of the uranium present in the sample, which is directly proportional to both the excitation source intensity and the uranium concentration present in the sample water.

Analysis of Uranium

We can use the 0.45 Whatmann micron filter paper that was employed to remove suspended particles

from the samples. When calibrating the instrument using standard uranium solutions, the matrix effect was eliminated by analyzing the water samples using the standard procedure. In the sample, sodium pyrophosphate (SPP), an inorganic reagent, is added to change all of the uranium compounds into a single form with a similar fluorescence yield due to the fluorescence yield varies throughout the complexes. Concentration may be detected with this technique down to 0.5 ug/l.

Reagent and Chemicals

Buffer Reagent

To maintain the pH range of 6.5–7.5, a five percent sodium pyrophosphate(SPP) solution was made and dropwise added orthophosphoric acid.

Sample Preparation

Now we can add 2 milliliters of nitric acid and 6 milliliters of HCl to the 25 milliliters water sample. The sample should be heated below boiling. Once the sample has reached room temperature, pour it into a 50 ml volumetric flask and use ultrapure water to fill it to the top. Use ultrapure water to rinse the beaker's inside wall. Centrifuge or filter the sample. After filtering the sample, put 10% nitric acid into a 100 ml volume.

Health Risk Assessment

Radiological Risk or Carcinogenic Risk Assessment

Estimation of Excess life time cancer risk

Equations 1 and 2 were approved by the USEPA, to determine the Excess lifetime cancer risk(ECR)

$$ECR = ADD \times SF \times 23250.5 \text{ (63.7 year)} \quad \dots(1)$$

$$ADD = ACU \times 27 \times AIW \quad \dots(2)$$

$$ECR = ADD(\text{pCi}) \times 0.62 \text{ Risk/pCi} \times 23250.5 \text{ (63.7 year)}$$

$$ECR = ADD(\text{pCi}) \times 0.6 \times 10^{-10} \times 23250.5$$

$$ACU = ECU \times 2.528 \times 10^{-2}$$

Where: ECR = excess cancer risk, ADD is average daily dose (pCi), ECU is the exposure concentration of Uranium ($\mu\text{g/l}$), SF is slope factor= 0.62 Risk/pCi¹⁰ ACU is the activity concentration of uranium(Bq/l)

1 µg/l uranium = 2.528 × 10⁻² Bq/l and 1 Bq = 27 pCi and AIW is average ingestion of water = 4.05l/day.¹⁸

expectancy = 63.7 (year) and BW is the body weight = 53 kg (for an Indian standard man).

Non-carcinogenic risk or chemical risk Assessment

Estimation of Hazard Quotient

To determine the chemical threat due to the ingesting the contaminated uranium water. The term of Hazard Quotient is used.

$$HQ = \frac{LADD}{RFD} \dots(3)$$

$$LADD = \frac{ECU \times AIW \times FE \times TED}{LE \times BW \times 365} \dots(4)$$

$$= \frac{ECU(\mu\text{g/l}) \times 4.05(\text{l/day}) \times 365(\text{days year}^{-1}) \times 63.7(\text{year})}{63.7(\text{year}) \times 53 \text{ kg} \times 365}$$

Equations 3 and 4 are used for estimation of the Hazard Quotient.

Where: LADD= life time average daily dose (ug kg⁻¹ day⁻¹) and RFD is reference dose=0.6 (µg kg⁻¹ day⁻¹)¹⁴ AIW is Average ingestion of water = 4.05(l/day), FE exposure frequency = 365 (days year⁻¹), ECU is the exposure concentration of Uranium (µg/l), TED is the total exposure duration = 63.7(year), LE is the life

Result and Discussion

Here, twenty-nine groundwater samples of Balod district, Chhattisgarh, were applied to the laser fluorimetric technique analysis, including the uranium concentration, corresponding cancer risk (radiological risk), lifetime average daily dose, cancer risk (chemical risk), and Hazard Quotient (HQ), which are tabulated in tables 1, 2, 3, and 4.

Evolution of Uranium Concentration

In the months of September 2022 to June 2023, in groundwater, the uranium concentration has been detected to be 0.10 – 40.3 µg/L in September 2022, 0.35 – 52.6 µg/L in December 2022, 0.48 – 65.8 µg/L in March 2023, and 0.45 - 66.7 µg/L in June 2023. Uranium concentration varies from a lower value of 0.10 to 66.7 µg/L in Chandanbirhi village to a higher value in Siwani village. The uranium concentration in 97% the sample of water is below the WHO permeable limit. Uranium concentration in months of March and June is slightly higher as compared to December and September due to both geogenic and human-induced sources.¹⁵

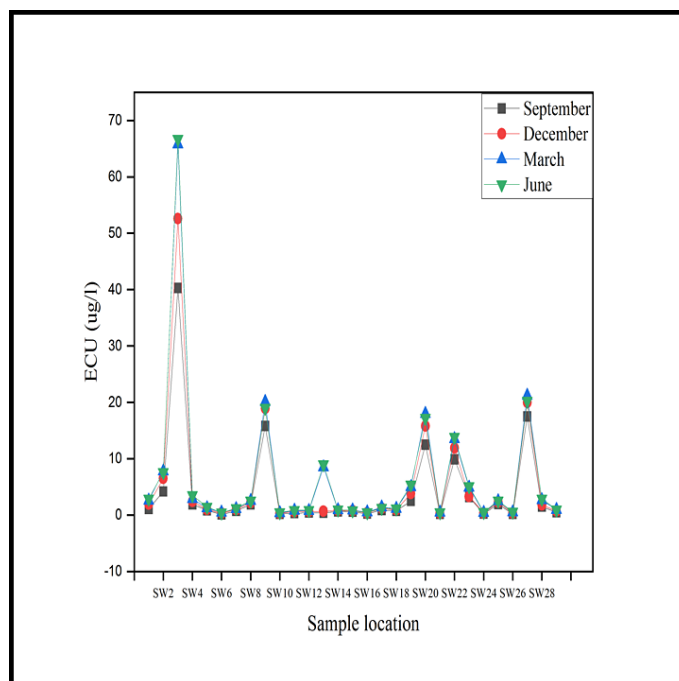


Fig. 2: monthly variation uranium concentration

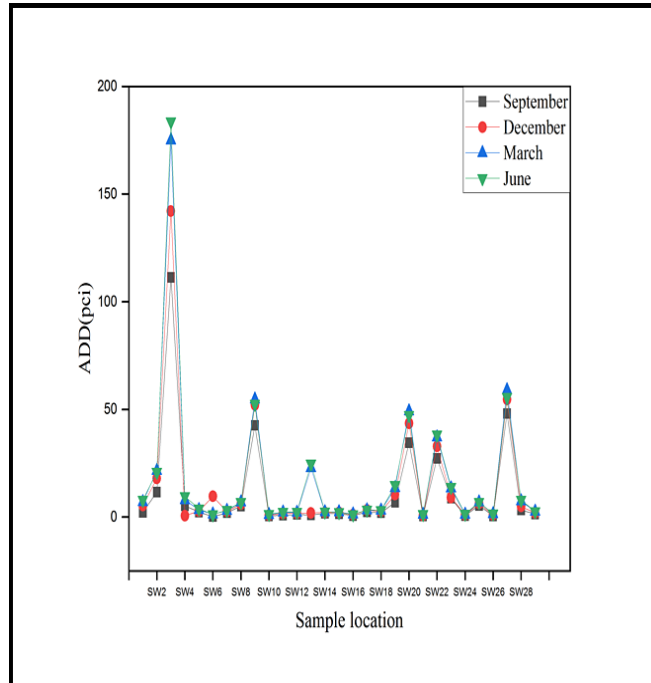


Fig. 3: monthly variation of ADD value

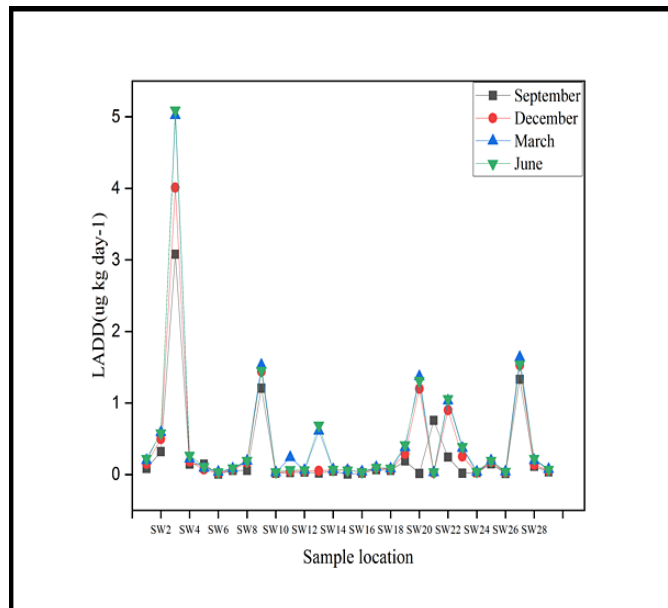


Fig. 4: Monthly variation of LADD

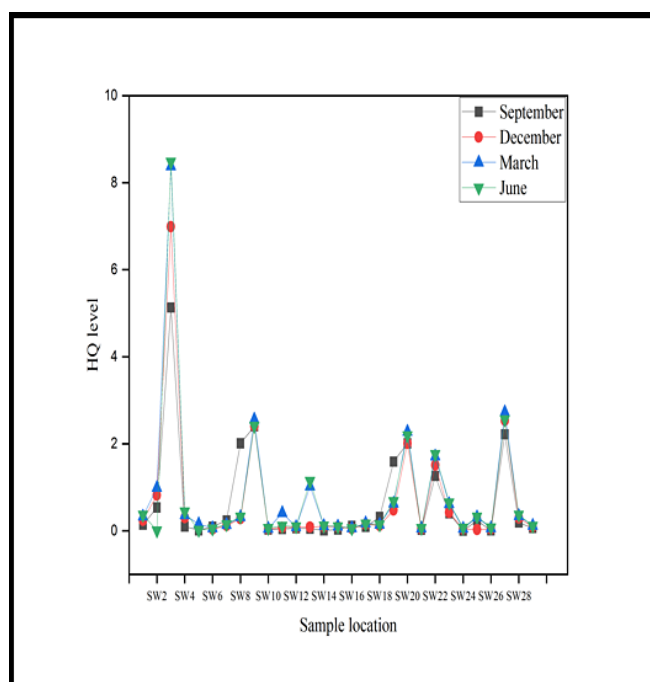


Fig. 5: Monthly variation of HQ

Table 1: concentration of uranium and carcinogenic, non-carcinogenic risk in month of Sept. 2022

S n	Location	ECU (ug/l)	ACU (Bq/l)	ADD (pci)	ECR	LADD (ug/kg ⁻¹ day ⁻¹)	HQ
SW ₁	Gorkhpur	1.1	0.02	2.187	3.1×10 ⁻⁶	0.084	0.140
SW ₂	Khapari	4.2	0.106	11.59	1.67×10 ⁻⁵	0.32	0.534
SW ₃	Siwani	40.3	1.018	111.3	1.60×10 ⁻⁴	3.079	5.132
SW ₄	Jarwaya	1.9	0.048	5.24	2.7×10 ⁻⁶	0.145	0.10
SW ₅	Madiyapar	0.84	0.021	2.29	3.3×10 ⁻⁶	0.145	0.012
SW ₆	Chandanbirhi	0.10	0.002	0.218	3.14×10 ⁻⁷	0.0064	0.095
SW ₇	Parastarai	0.75	0.018	1.968	2.8×10 ⁻⁶	0.057	0.239
SW ₈	Bhaurkhabhat	1.88	0.047	5.13	7.39×10 ⁻⁶	0.057	0.095
SW ₉	Bharda	15.8	0.39	42.6	6.14×10 ⁻⁵	1.207	2.40
SW ₁₀	Bhalukona	0.21	0.005	0.54	7.7×10 ⁻⁷	0.016	0.026
SW ₁₁	Bamhani	0.35	0.008	0.874	1.25×10 ⁻⁶	0.026	0.044
SW ₁₂	Kapasi	0.45	0.001	1.202	1.73×10 ⁻⁶	0.035	0.058
SW ₁₃	Phulzar	0.39	0.009	0.98	1.4×10 ⁻⁶	0.02	0.049
SW ₁₄	Sorali	0.65	0.016	1.74	2.50×10 ⁻⁶	0.049	0.01
SW ₁₅	Medki	0.58	0.014	1.53	2.2×10 ⁻⁶	0.006	0.03
SW ₁₆	Balodgaon	0.25	0.006	0.656	9.1×10 ⁻⁷	0.019	0.11
SW ₁₇	Bori	0.89	0.022	2.40	3.45×10 ⁻⁶	0.068	0.09
SW ₁₈	Matiya	0.75	0.018	1.968	2.83×10 ⁻⁶	0.057	0.318
SW ₁₉	Satmara	2.5	0.063	6.88	1.00×10 ⁻⁵	0.191	1.59

SW ₂₀	Bhothali	12.5	0.316	34.5	4.97×10 ⁻⁵	0.015	2.01
SW ₂₁	Dubechera	0.2	0.005	0.546	7.87×10 ⁻⁷	0.756	0.02
SW ₂₂	Sonhatera	9.9	0.250	27.3	3.93×10 ⁻⁶	0.244	1.26
SW ₂₃	Bhejamaidani	3.2	0.080	8.74	1.25×10 ⁻⁵	0.018	0.40
SW ₂₄	Nawgaon	0.24	0.006	0.65	9.36×10 ⁻⁷	0.028	0.003
SW ₂₅	Sankara	1.96	0.049	5.35	7.7×10 ⁻⁶	0.148	0.24
SW ₂₆	Marri	0.2	0.005	0.54	7.87×10 ⁻⁷	0.015	0.009
SW ₂₇	Monagari	17.5	0.44	48.1	6.93×10 ⁻⁵	1.33	2.22
SW ₂₈	Bhimkanhar	1.5	0.03	3.28	4.7×10 ⁻⁶	0.114	0.19
SW ₂₉	Ghurvatola	0.52	0.013	1.42	2.04×10 ⁻⁶	0.039	0.066

Table 2: concentration of uranium and carcinogenic, non-carcinogenic risk in month of Dec. 2022.

S n	Location	ECU (ug/l)	ACU (Bq/l)	ADD (pci)	ECR	LADD (ug/kg ⁻¹ day ⁻¹)	HQ
SW ₁	Gorkhpur	1.95	0.049	5.35	7.7×10 ⁻⁶	0.149	0.24
SW ₂	Khapari	6.5	0.164	17.9	2.58×10 ⁻⁵	0.496	0.82
SW ₃	Siwani	52.6	1.32	142.1	2.0×10 ⁻⁴	4.01	6.99
SW ₄	Jarwaya	2.4	0.006	0.65	9.4×10 ⁻⁶	0.183	0.30
SW ₅	Madiyapar	1.0	0.025	2.73	3.9×10 ⁻⁶	0.071	0.127
SW ₆	Chandanbirhi	0.35	0.088	9.62	1.38×10 ⁻⁶	0.02	0.04
SW ₇	Parastari	0.98	0.024	2.62	3.7×10 ⁻⁶	0.07	0.122
SW ₈	Bhaurkhabhat	2.2	0.055	6.01	8.6×10 ⁻⁶	0.168	0.28
SW ₉	Bharda	18.9	0.477	52.1	7.5×10 ⁻⁴	1.44	2.40
SW ₁₀	Bhalukona	0.32	0.008	0.87	1.25×10 ⁻⁶	0.024	0.04
SW ₁₁	Bamhani	0.6	0.015	1.65	2.3×10 ⁻⁶	0.045	0.076
SW ₁₂	Kapasi	0.64	0.016	1.76	2.5×10 ⁻⁶	0.048	0.081
SW ₁₃	Phulzar	0.68	0.017	1.869	2.6×10 ⁻⁶	0.051	0.086
SW ₁₄	Sorali	0.82	0.02	2.187	2.3×10 ⁻⁶	0.062	0.10
SW ₁₅	Medki	0.78	0.019	2.154	3.0×10 ⁻⁶	0.059	0.094
SW ₁₆	Balodgaon	0.42	0.01	1.093	1.57×10 ⁻⁶	0.032	0.053
SW ₁₇	Bori	1.2	0.03	3.28	3.7×10 ⁻⁶	0.091	0.152
SW ₁₈	Matiya	0.95	0.024	2.624	1.49×10 ⁻⁶	0.072	0.12
SW ₁₉	Satmara	3.8	0.096	10.4	6.28×10 ⁻⁵	0.29	0.48
SW ₂₀	Bhothali	15.8	0.399	43.6	1.0×10 ⁻⁵	1.20	2.01
SW ₂₁	Dubechera	0.31	0.007	0.765	4.7×10 ⁻⁷	0.023	0.039
SW ₂₂	Sonhatera	11.9	0.30	32.8	1.3×10 ⁻⁵	0.90	1.51
SW ₂₃	Bhejamaidani	3.3	0.083	9.07	1.4×10 ⁻⁵	0.25	0.42
SW ₂₄	Nawgaon	0.37	0.009	1.01	9.1×10 ⁻⁶	0.028	0.04
SW ₂₅	Sankara	2.3	0.058	6.35	1.38×10 ⁻⁵	0.175	0.292
SW ₂₆	Marri	0.35	0.008	0.96	7.87×10 ⁻⁶	0.026	0.04
SW ₂₇	Monagari	20.0	0.50	54.6	7.8×10 ⁻⁴	1.528	2.54
SW ₂₈	Bhimkanhar	1.8	0.045	4.92	7.0×10 ⁻⁵	0.137	0.229
SW ₂₉	Ghurvatola	0.73	0.018	1.96	2.8×10 ⁻⁶	0.055	0.09

Table 3: concentration of uranium and carcinogenic, non-carcinogenic risk in month of march 2023.

S n	Location	ECU (ug/l)	ACU (Bq/l)	ADD (pci)	ECR	LADD (ug/kg ⁻¹ day ⁻¹)	HQ
SW ₁	Gorkhpur	2.6	0.065	7.10	1.0×10 ⁻⁵	0.198	0.33
SW ₂	Khapari	7.8	0.197	21.54	3.1×10 ⁻⁵	0.59	0.99
SW ₃	Siwani	65.8	1.66	174.96	2.5×10 ⁻⁴	5.02	8.38
SW ₄	Jarwaya	22.9	0.073	7.98	1.15×10 ⁻⁵	0.22	0.36
SW ₅	Madiyapar	1.25	0.031	3.38	4.8×10 ⁻⁶	0.09	0.159
SW ₆	Chandanbirhi	0.48	0.012	1.31	1.88×10 ⁻⁶	0.036	0.06
SW ₇	Parastarai	1.10	0.027	2.95	4.2×10 ⁻⁶	0.08	0.14
SW ₈	Bhaurkhabhat	2.52	0.063	6.88	9.9×10 ⁻⁶	0.19	0.32
SW ₉	Bharda	20.12	0.50	54.67	7.88×10 ⁻⁴	1.53	2.56
SW ₁₀	Bhalukona	0.40	0.01	1.09	1.57×10 ⁻⁶	0.03	0.05
SW ₁₁	Bamhani	0.80	0.02	2.18	3.14×10 ⁻⁶	0.24	0.41
SW ₁₂	Kapasi	0.78	0.019	2.07	2.98×10 ⁻⁶	0.059	0.09
SW ₁₃	Phulzar	8.50	0.21	22.9	3.3×10 ⁻⁵	0.61	1.02
SW ₁₄	Sorali	0.90	0.022	2.40	3.45×10 ⁻⁶	0.068	0.11
SW ₁₅	Medki	0.85	0.021	2.29	3.3×10 ⁻⁶	0.06	0.10
SW ₁₆	Balodgaon	0.50	0.012	1.31	1.88×10 ⁻⁶	0.038	0.06
SW ₁₇	Bori	1.40	0.03	3.28	4.72×10 ⁻⁶	0.10	0.178
SW ₁₈	Matiya	1.15	0.029	3.17	4.56×10 ⁻⁶	0.08	0.146
SW ₁₉	Satmara	4.98	0.125	13.6	1.96×10 ⁻⁵	0.38	0.63
SW ₂₀	Bhothali	17.98	0.45	49.2	7.09×10 ⁻⁵	1.37	2.28
SW ₂₁	Dubechera	0.47	0.011	1.20	1.72×10 ⁻⁶	0.03	0.059
SW ₂₂	Sonhatera	13.50	0.34	37.17	5.35×10 ⁻⁵	1.03	1.71
SW ₂₃	Bhejamaidani	4.9	0.123	13.45	1.93×10 ⁻⁵	0.37	0.62
SW ₂₄	Nawgaon	0.45	0.011	1.235	1.78×10 ⁻⁶	0.034	0.05
SW ₂₅	Sankara	2.50	0.063	6.88	9.17×10 ⁻⁶	0.191	0.31
SW ₂₆	Marri	0.52	0.013	1.421	2.04×10 ⁻⁶	0.039	0.066
SW ₂₇	Monagari	21.2	0.54	59.0	8.5×10 ⁻⁴	1.64	2.73
SW ₂₈	Bhimkanhar	2.7	0.068	7.43	1.07×10 ⁻⁵	0.20	0.34
SW ₂₉	Ghurvatola	0.96	0.024	2.64	3.8×10 ⁻⁶	0.073	0.12

Table 4: concentration of uranium and carcinogenic, non-carcinogenic risk in month of June 2023.

S n	Location	ECU (ug/l)	ACU (Bq/l)	ADD (pci)	ECR	LADD (ug/kg ⁻¹ day ⁻¹)	HQ
SW ₁	Gorkhpur	2.9	0.073	7.98	1.15×10 ⁻⁵	0.221	0.369
SW ₂	Khapari	7.6	0.192	20.99	3.02×10 ⁻⁵	0.580	0.01
SW ₃	Siwani	66.7	1.68	183.7	2.64×10 ⁻⁴	5.09	8.48
SW ₄	Jarwaya	3.5	0.088	9.62	1.38×10 ⁻⁵	0.267	0.445
SW ₅	Madiyapar	1.43	0.036	3.93	4.88×10 ⁻⁶	0.109	0.0182
SW ₆	Chandanbirhi	0.45	0.0113	1.235	1.77×10 ⁻⁶	0.034	0.05

SW ₇	Parastarai	1.19	0.030	3.28	4.72×10 ⁻⁶	0.09	0.151
SW ₈	Bhaurkhabhat	2.56	0.0647	6.99	1.0×10 ⁻⁵	0.195	0.326
SW ₉	Bharda	19.0	0.48	52.48	7.56×10 ⁻⁴	1.45	2.41
SW ₁₀	Bhalukona	0.48	0.012	1.296	1.86×10 ⁻⁶	0.036	0.061
SW ₁₁	Bamhani	0.88	0.022	2.40	3.4×10 ⁻⁶	0.067	0.11
SW ₁₂	Kapasi	0.84	0.021	2.296	3.3×10 ⁻⁶	0.064	0.10
SW ₁₃	Phulzar	9.0	0.227	24.8	3.57×10 ⁻⁵	0.687	1.145
SW ₁₄	Sorali	0.94	0.023	2.51	3.61×10 ⁻⁶	0.071	0.119
SW ₁₅	Medki	0.79	0.0199	2.17	3.12×10 ⁻⁶	0.060	0.100
SW ₁₆	Balodgaon	0.46	0.0116	1.25	1.80×10 ⁻⁶	0.035	0.058
SW ₁₇	Bori	1.26	0.031	3.38	4.87×10 ⁻⁶	0.096	0.16
SW ₁₈	Matiya	1.13	0.0285	3.078	4.43×10 ⁻⁶	0.086	0.143
SW ₁₉	Satmara	5.4	0.136	14.8	2.13×10 ⁻⁵	0.412	0.68
SW ₂₀	Bhothali	17.20	0.434	47.3	6.81×10 ⁻⁵	1.314	2.195
SW ₂₁	Dubechera	0.49	0.012	1.296	1.86×10 ⁻⁶	0.037	0.062
SW ₂₂	Sonhatera	13.85	0.350	38.25	5.51×10 ⁻⁵	1.058	1.763
SW ₂₃	Bhejamaidani	5.1	0.128	13.97	2.01×10 ⁻⁵	0.389	0.649
SW ₂₄	Nawgaon	0.54	0.0136	1.486	2.14×10 ⁻⁶	0.041	0.068
SW ₂₅	Sankara	2.54	0.064	6.99	1.00×10 ⁻⁵	0.194	0.323
SW ₂₆	Marri	0.58	0.014	1.53	2.20×10 ⁻⁶	0.044	0.073
SW ₂₇	Monagari	20.23	0.51	55.7	8.02×10 ⁻⁴	1.54	2.56
SW ₂₈	Bhimkanhar	2.9	0.073	7.98	1.15×10 ⁻⁵	0.221	0.369
SW ₂₉	Ghurvatola	0.94	0.0237	2.58	3.7×10 ⁻⁶	0.071	0.11

Evaluation of Radiological Risk

ECR (excess cancer risk) varies from 3.14×10^{-7} to 1.60×10^{-4} in September 2022, 1.38×10^{-6} to 2.0×10^{-4} in December 2022, 1.88×10^{-6} to 2.5×10^{-4} in March 2023 and 1.77×10^{-6} to 2.64×10^{-4} in June 2023. The acceptable range of excess lifetime cancer risk (ELCR) is 1×10^{-4} as established by USEPA. Compared to the allowable thresholds, the reported cancer risk (CR) levels for most of the water samples are low, except for Siwani village. If uranium is ingested, its alpha emissions have a direct radiation effect that can lead to genetic mutations, irregularities in the formation of the foetus and growing of kids, and cancer.¹⁶

Evaluation of non Carcinogenic Risk

The LADD ranges from 0.0064 to 3.079 in the month of September 2022, 0.02 to 4.01 in December 2022, 0.06 to 5.02 in March 2023 and 0.034 to 5.09 $\mu\text{g kg}^{-1} \text{day}^{-1}$ in June 2023. 82% of the water sample LADD value is below $1 \mu\text{g kg}^{-1} \text{day}^{-1}$ which is in under the WHO guidelines. HQ Level of 76 % water sample is below the one which is accepted by WHO. The LADD value of 18% and HQ value of 24% of the water sample exceed the permissible limit, which indicates a high risk of chemical poison.

Comprehensive Study

In this study, we use laser-induced fluorimetry to identify the uranium contamination in groundwater. From September 2022 to June 2023, sample collection was done from different places of Balod district, Chhattisgarh. Balod is a mineral-rich district, and most of the area is used for agricultural work and industrial purposes. So the uranium concentration in this area of groundwater rises from September 2022 to June 2023. Except for one sample, the level of uranium in all samples is low the permissible level. Geogenic main sources of uranium in groundwater are breaking and dissolving mineral-rich rocks by streams, and human induced sources are, phosphate fertilizer used for agricultural work, mining of gas, phosphate and oil industries, waste from war and atomic power plants, and decline of the groundwater level. Uranium has radioactive properties, external exposure to uranium is not as greater risk as to other radioactive material as inhalation or intake at a higher amount of uranium. Radiological effect or cancer risk are low in this area, one village has a cancer risk is close to the cancer risk threshold limit. The radiation effect of uranium cause many diseases, including skin cancer, lung cancer, liver cancer, kidney cancer, reproductive disabilities,

irregularities of sex hormones, and decreased the fertility of males. non-carcinogenic risk poses in this area due to the chemical characteristics of uranium. One out of the each four samples, indicating chemical risk from ingesting uranium-contaminated water. The chemical poisoning of uranium on humans causes, its affected, kidney damage, cardiovascular issues, and heart failure, and damage to the central nervous system, such as amnesia, anxiety, neurobehavioral abnormalities,

and irregularities in sleep wake cycles. The purpose of the study was to make people aware and tell them about the carcinogenic and non-carcinogenic risk to people from consuming contaminated uranium water. Groundwater of Balod district, Chhattisgarh, is needed remediation and monitoring.

Comparing the Amount of Uranium Identify in Previous Studies.

Table 5: Levels of uranium identified in drinking water in various Chhattisgarh districts.

District	Uranium Concentration ($\mu\text{g/l}$)	References
Korba	0.031 - 140.1	38
Baster	0.50 - 26.4	33
Durg	0.638 - 45.7	34
Bijapur	0.21 - 10.4	35
Balod	0.563 - 78.93	1,4
Raipur	0.2 - 13	37
Bemetara	1.15 - 83.5	13
Rajnandgaon	0.5 - 99.9	36

Table 6: Levels of uranium found in drinking water in various Indian states.

Indian state (cities)	Uranium Concentration ($\mu\text{g/l}$)	References
Assam (Nalbari)	0.3-10.3	15
Southwest Punjab	0.5 - 579	9
West Haryana	0.3 - 256.4	24
Andhra-Pradesh (visakhapatanam)	0.6 - 12.3	7
Karnataka (Chamarajanagar)	0.03 - 4.63	27
Punjab(Bhatind)	9.72 -186.6	20
Eastern Utter Pradesh	0.3 - 63.33	21
Current study	0.10 - 66.7	

Conclusion

Water is important for survival. So it is essential to identify the amount of uranium in water. The current study's range of uranium concentrations in groundwater was significantly lower than the

WHO's acceptable threshold value. concentration of uranium above the acceptable level only in the Siwani village. Uranium concentration increased from September 2022 to December 2022 and from December 2022 to March and June 2023 due to

the breakdown of uranium from soil sediments during the rain, by dissolution, fertilization with phosphate and nitrate from agriculture may be the source of uranium in the groundwater. The value of ECR, LADD, and HQ increases from the month of September 2022 to December 2022 due to the increasing concentration of uranium in groundwater. The ECR value is slightly high in Siwani village and the ECR for Bharda and Monagari is very close to the acceptable range of 1×10^{-4} . When compared to the radiological risk permitted level of 10⁻³, the results indicate cancer risk (CR) is low. The Hazard Quotient in Siwani Village was expected to be 5.13 in the month of September 2022, 6.9 in December 2022, 8.38 in March 2023 and 8.48 in June 2023, indicating that this region needs properly monitoring and remedial action. The study found that the area's uranium's chemical toxicity may be the cause of non-carcinogenic health problems, but eventually, there is no carcinogenic (radiological) risk to people.

Acknowledgements

Authors are thankful to Department of Chemistry, Bharti Vishvavidyalya, Durg for providing lab facilities

One author is also thankful to one consultant labs for providing some instrument facilities.

Funding Sources

There is no funding support of any kind for this work.

Conflict of Interest

Authors have no competing of interest.

Data Availability Statement

Experimental data.

Ethics Statement

In this study no involves an experiment on human and animals.

Authors' Contribution

Sheshkumari sahu : Experimentation, collection of samples Writing–draft and corresponding author, Manoj kumar Ghosh: Supervision, Writing–review editing.

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