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## **A Comprehensive Study of Uranium Concentration in Kathua & Samba District of Jammu & Kashmir**

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### **Abstract**

A study on Uranium contamination in Ground water which is the major source for drinking water and irrigation in Kathua and Samba district of Jammu & Kashmir has been presented. Provoked by various water quality issues in the region a new study on Uranium contamination samples in Kathua and Samba has been reported. Uranium concentration was determined through Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) technique. 30 samples of Kathua and have been analyzed with minimum and maximum values being 0.043 ppb and 11.599 ppb respectively with mean value 1.96 ppb. For Samba district 46 samples were analyzed with minimum and maximum values being 0.055 ppb and 10.878 ppb respectively with mean value 2.90 ppb which depict that the uranium concentration in water samples of both the districts are well with on the range of 30 ppb prescribed by World Health Organization (WHO) and US Environmental Protection Agency.

**Keywords:** ground water, uranium, ICP-MS, contamination

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### **Introduction**

The population in India is increasing day by day. It is second most populous country in the world. With increase in the population dependency on usage of natural resources has been escalated. For drinking water and irrigation purposes, India is mainly dependent on the groundwater. 90% of ground water is used for irrigation purposes (1). The main source of drinking water in India is also ground water. With increase in urbanization and population ground water sources are depleting (2,3). As per the Central Ground Water Board India which is the apex governing body for management of ground water resources in the country, many areas in the country have become overexploited, critical and semi critical with respect to ground water exploitation (4). However no such overexploitation seen in Jammu and Kashmir. The depletion of ground water is not only the issue India facing but contamination of ground water is also the major problem as indicated by numerous studies with high levels of arsenic, nitrate, fluoride in ground water (5-7). Since ground water is used for drinking purpose, it must be free from any contamination. These days one of the major contaminants is radioactive element namely Uranium. It is also significantly found in ground water. Uranium is mobilized to groundwater from rocks due to weathering and natural erosion processes. It can also be present in groundwater due to anthropogenic activities (nuclear waste disposal) and geogenic sources such as mining activities etc.(8). The presence of uranium in drinking water is harmful to living organisms (9,10). The chemical properties of uranium has toxic effects on human health and may damage kidney, liver, reproductive system etc. The World health Organisation has prescribed the permissible value of 30 ppb for uranium concentrations in drinking water (11). The United States Environment Protection Agency has recommended the limit of 30 ppb of Uranium (12). The Atomic Energy Regulatory Board (AERB) of India has permissible limit of 60 ppb for drinking water (13). Several studies have been conducted in India to assess

the level of contamination of uranium present in the groundwater. Here we present the study of uranium contamination in Kathua and Samba area of Jammu & Kashmir.

### **Study Area**

The present study of uranium contamination was studied in Kathua and Samba area of Jammu & Kashmir. Kathua is one of the prominent district of J&K and often referred to as the Gateway of Jammu & Kashmir. It is situated at 32° 17' to 32° 55' North Latitude and 75° 70' to 76° 16' East longitude. The District is surrounded by Gurdaspur of Punjab in the South-East, Chamba of Himachal Pradesh in North-East, Doda and Udhampur in North and North-West, Jammu in the West and in the South-West it shares its border with Pakistan. Agriculture is the major source of livelihood in the district. The temperature rises from minimum 3°C to maximum 48°C. The district has two hilly tehsils where snowfall is experienced and temperature touches sub zero. The average annual rainfall of the district is 1360 mm out of which 85 % experienced is during the monsoon season. The physiography of the district consists of high mountain ranges, valleys, gorges and canyons. The elevation in the area is varying from 280 m amsl to 3000 m amsl. The district is drained by many streams, which originates from mountainous region. The major rivers draining the district are Ravi, Ujh and Sewa. Besides this, there are number of seasonal streams (khads) in the whole district which contains boulders, pebbles, sand and silt during monsoon.

Samba district is situated along the national highways on the foothill of Shivalik hills at altitude of 384 meters (1259 feet) above sea level, on the bank of river Basantar. District Samba is surrounded by District Udhampur in the North, District Kathua in the east, Tehsil Jammu and Bishnah of District Jammu in the west. It has a 55.5 KM long International Border with Pakistan on the southern side. It is located 40 kilometers from Jammu city.

About two third of the area of Samba is Kandi area and is rain fed. The area on the southern side is irrigated through Ravi Tawi Irrigation canal network and contributes towards crop production. The district has two industrial growth centers one at Bari Brahmana and other at Samba which makes the district a industrial hub. The district is located in the sub tropical zone, and climate is hot and dry in summer and cold in winter. The nights are bit cooler than due to its existence in the foothills of the

Shivalik hills. The temperature ranges from 6°C to 47°C. The two important rivers of the District are namely, Basanter and Devak or Devika. Basanter, on the banks of which Samba town is located is a tributary of River Ravi and is famous for the Battle of Basanter, fought between India & Pakistan in 1971. Devak, a tributary of Ujh River (Ravi river basin) It is also known as “Gupta Ganga” for its unique feature of flowing under the river bed except in monsoons when it is in its full flow.

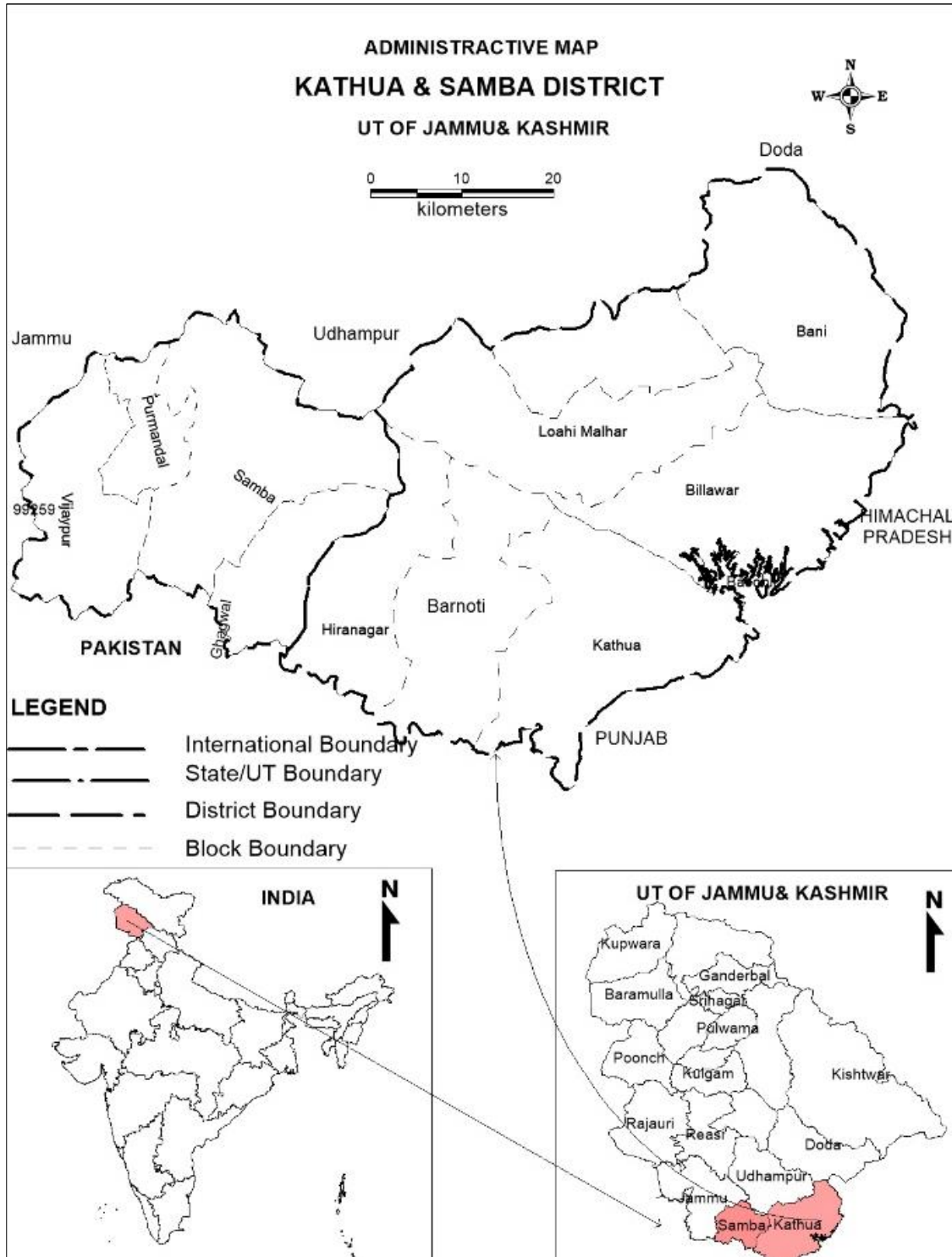


Fig 1: Administrative map of Kathua and Samba district of Jammu & Kashmir.

## Geology of the Areas

The Kathua-Samba district can be divided into three Agro-climatic regions of deep alluvial soils, Shivalik ranges namely Kandi area and third area falls beyond Shivalik ranges and extends upto Peer Panchal Ranges. The area of deep alluvial soils is mostly irrigated and quite productive. The second zone i.e. Kandi zone extends upto foothills of Himalayas and falling mostly in Shivalik ranges. It is characterized by shallow soils full of boulders with negligible natural water resources. The third area is mountainous in nature with little potential for agriculture.

## Methods

### Sampling and Preservation

For determining the uranium concentration in the groundwater of the district, total 47 samples were collected from different National Hydrograph stations installed by Central Ground Water Board in the district. The samples were divided in two parts one part for the analysis of uranium and other part for the analysis of other chemical constituents such as pH, electrical conductivity etc. The samples were filtered using Whatman filter paper number 1.

## ICP-MS

For the determination of uranium in water samples, the water samples are acidified with 3% Nitric Acid ( $\text{HNO}_3$ ). The analysis of uranium samples were carried out using Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) at Central Ground Water Board Laboratory, Northern Western Region, Chandigarh. This instrument works on the technique of induced coupled plasma to produce ions and then mass spectroscopy to detect the ions on the basis of charge and mass.

## Results and Discussion

### Estimation of Uranium

The values of uranium determined in 46 samples of Kathua district of Jammu & Kashmir is given in Table-1. The samples are well within the range of limit prescribed by WHO of 30 ppb. The minimum and maximum values are 0.043 ppb and 11.60 ppb respectively with mean value 2.200 ppb. Uranium activity is also calculated using conversion factor 1 ppb uranium = 0.02528 Bq  $\text{l}^{-1}$

**Table 1:** Concentration of uranium in water samples of Kathua district.

Sr. No.	Location	District	Source	Uranium Concentration (ppb)	Uranium Activity Concentration (Bq $\text{l}^{-1}$ )
1.	Chan Khatrian	Kathua	Dugwell	0.879	0.022228
2.	Feruchak	Kathua	Dugwell	1.714	0.043322
3.	Gangu Chak	Kathua	Dugwell	2.319	0.058621
4.	Hore	Kathua	Dugwell	0.255	0.006448
5.	Jandi (New)	Kathua	Dugwell	0.837	0.021162
6.	Karol Krishna	Kathua	Dugwell	5.468	0.138237
7.	Konthal	Kathua	Dugwell	3.578	0.09044
8.	Kootah	Kathua	Dugwell	0.128	0.003239
9.	Londi	Kathua	Dugwell	1.515	0.038308
10.	Mandli	Kathua	Dugwell	2.097	0.053012
11.	Nagrot-Gujroo	Kathua	Dugwell	0.907	0.022926
12.	Pallan	Kathua	Dugwell	0.163	0.00413
13.	Pansar	Kathua	Dugwell	8.801	0.222497
14.	Phinter	Kathua	Dugwell	0.163	0.004119
15.	Ramkot	Kathua	Dugwell	2.620	0.066221
16.	Barni	Kathua	Dugwell	0.133	0.003368
17.	Kerian Ramnagar	Kathua	Dugwell	11.599	0.29322
18.	Lakhanpur Fort	Kathua	Dugwell	0.046	0.001171
19.	Bhagwal	Kathua	Dugwell	0.139	0.003524
20.	Chapki Kalan	Kathua	Dugwell	0.211	0.00533
21.	Khanpur	Kathua	Dugwell	0.499	0.012626
22.	Chkhariya	Kathua	Dugwell	1.304	0.032957
23.	Mukhandpur	Kathua	Dugwell	0.817	0.020665
24.	Kotepannu	Kathua	Dugwell	0.657	0.016621
25.	Sumwan	Kathua	Dugwell	1.393	0.03521
26.	Nanke Chak	Kathua	Dugwell	0.043	0.001097
27.	Kothian	Kathua	Dugwell	0.091	0.002309
28.	Nagri	Kathua	Dugwell	0.215	0.005429
29.	Gond More	Kathua	Dugwell	2.486	0.062836
30.	Chanranga	Kathua	Dugwell	0.152	0.003839

Minimum - 0.043

Maximum - 11.599

Average - 1.964

**Table 2:** Concentration of uranium in water samples of Samba district.

Sr. No.	Location	District	Source	Uranium Concentration (ppb)	Uranium Activity Concentration (Bq l <sup>-1</sup> )
1.	Bengular	Samba	Dugwell	1.398	0.035347
2.	Dabho	Samba	Dugwell	2.500	0.063202
3.	Nud	Samba	Dugwell	5.165	0.130563
4.	Rehian (Raiyan)	Samba	Dugwell	1.676	0.042361
5.	Samba	Samba	Dugwell	0.418	0.010563
6.	Gura (Akhnoor)	Samba	Dugwell	0.355	0.008977
7.	Jaswan	Samba	Dugwell	1.326	0.033531
8.	Sagoon	Samba	Dugwell	3.517	0.088911
9.	Surinsar	Samba	Dugwell	4.025	0.101757
10.	Bassi Kalan	Samba	Dugwell	3.519	0.088966
11.	Birpur	Samba	Dugwell	1.386	0.035049
12.	Didyal	Samba	Dugwell	1.018	0.025746
13.	Gho-Brahamana	Samba	Dugwell	2.409	0.060905
14.	Gudwal	Samba	Dugwell	5.371	0.135777
15.	Gho-Rakhwalan	Samba	Dugwell	0.808	0.020422
16.	Kainthpur	Samba	Dugwell	5.122	0.129497
17.	Khairi (Bishna)	Samba	Dugwell	4.135	0.104523
18.	Kamila	Samba	Dugwell	0.414	0.010463
19.	Majua Laxmi	Samba	Dugwell	3.820	0.096570
20.	Patli	Samba	Dugwell	2.244	0.056735
21.	Palli	Samba	Dugwell	10.102	0.255384
22.	Supwal	Samba	Dugwell	2.100	0.053091
23.	Swankha	Samba	Dugwell	0.525	0.013263
24.	Uttarbani	Samba	Dugwell	1.787	0.045186
25.	Dhora	Samba	Dugwell	6.021	0.152205
26.	Penthi (Painthi)	Samba	Dugwell	0.221	0.005591
27.	Channi Marsar	Samba	Dugwell	1.755	0.044372
28.	Mahalshah Kalandrian	Samba	Dugwell	10.262	0.259436
29.	Upperla Kanhal	Samba	Dugwell	2.006	0.050714
30.	Dulma Chak	Samba	Dugwell	2.065	0.052209
31.	Jasath	Samba	Dugwell	1.068	0.027004
32.	Lalachak	Samba	Dugwell	5.331	0.134766
33.	Lokli	Samba	Dugwell	0.055	0.001389
34.	Madun	Samba	Dugwell	10.878	0.275002
35.	Naran	Samba	Dugwell	1.045	0.026417
36.	Nauni	Samba	Dugwell	3.547	0.089666
37.	Nilcha	Samba	Dugwell	0.500	0.012635
38.	Pangdaur	Samba	Dugwell	1.406	0.035533
39.	Patyari II (Kootah area)	Samba	Dugwell	2.504	0.063296
40.	Plura (Phalora)	Samba	Dugwell	2.450	0.061931
41.	Raghuchak	Samba	Dugwell	1.188	0.030022
42.	Sadoh	Samba	Dugwell	1.815	0.045892
43.	Saida	Samba	Dugwell	0.966	0.024432
44.	Sanoora	Samba	Dugwell	1.417	0.035816
45.	Kerian Gandyal II	Samba	Dugwell	6.592	0.166646
46.	Patyari	Samba	Dugwell	0.114	0.002875

Minimum - 0.055

Maximum – 10.878

Average – 2.90



Fig 2: Spatial Distribution of Uranium in Kathua and Samba district of Jammu & Kashmir

**Chemical Risk Assessment**

Chemical risk to life due to ingestion of water which contains uranium is given by life time daily dose (LADD) is given in table 3 & 4 of Kathua and Samba district respectively (14-16). It is calculated using following equation

$$\text{LADD of drinking water} = \frac{\text{EPC} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{AT} \times \text{BW}} \tag{i}$$

Where LADD is lifetime average daily dose ( $\mu\text{g kg}^{-1} \text{d}^{-1}$ )  
 EPC is exposure point concentration ( $\mu\text{g l}^{-1}$ )  
 IR is the water ingestion rate ( $2 \text{ l d}^{-1}$ ) ..... (11, 17)  
 EF is exposure frequency ( $350 \text{ dy}^{-1}$ )..... (17)  
 ED is the total exposure duration (45.5 years)  
 AT is the average time (16,607.5 days obtained using  $45.5 \times 365$ )  
 BW is body weight of man taken as standard 70 kg

Table 3: Chemical Risk Assessment for Kathua District

Sr. No.	Location	Uranium Concentration (ppb)	LADD ( $\mu\text{g kg}^{-1} \text{d}^{-1}$ )	Hazard Quotient
1.	Chan Khatrian	0.879	0.0241	0.0401
2.	Feruchak	1.714	0.0470	0.0783
3.	Gangu Chak	2.319	0.0635	0.1059
4.	Hore	0.255	0.0070	0.0116
5.	Jandi (New)	0.837	0.0229	0.0382
6.	Karol Krishna	5.468	0.1498	0.2497
7.	Konthal	3.578	0.0980	0.1634
8.	Kootah	0.128	0.0035	0.0058
9.	Londi	1.515	0.0415	0.0692
10.	Mandli	2.097	0.0575	0.0958
11.	Nagrota-Gujroo	0.907	0.0248	0.0414
12.	Pallan	0.163	0.0045	0.0074
13.	Pansar	8.801	0.2411	0.4019
14.	Phinter	0.163	0.0045	0.0074

15.	Ramkot	2.620	0.0718	0.1196
16.	Barni	0.133	0.0036	0.0061
17.	Kerian Ramnagar	11.599	0.3178	0.5296
18.	Lakhanpur Fort	0.046	0.0013	0.0021
19.	Bhagwal	0.139	0.0038	0.0063
20.	Chapki Kalan	0.211	0.0058	0.0096
21.	Khanpur	0.499	0.0137	0.0228
22.	Chkhariya	1.304	0.0357	0.0595
23.	Mukhandpur	0.817	0.0224	0.0373
24.	Kotepannu	0.657	0.0180	0.0300
25.	Sumwan	1.393	0.0382	0.0636
26.	Nanke Chak	0.043	0.0012	0.0020
27.	Kothian	0.091	0.0025	0.0042
28.	Nagri	0.215	0.0059	0.0098
29.	Gond More	2.486	0.0681	0.1135
30.	Chanranga	0.152	0.0042	0.0069

**Table 4:** Chemical Risk Assessment for Samba District

Sr. No.	Location	Uranium Concentration (ppb)	LADD ( $\mu\text{g kg}^{-1} \text{d}^{-1}$ )	Hazard Quotient
1.	Bengular	1.398	0.0383	0.064
2.	Dabho	2.500	0.0685	0.114
3.	Nud	5.165	0.1415	0.236
4.	Rehian (Raiyan)	1.676	0.0459	0.077
5.	Samba	0.418	0.0115	0.019
6.	Gura (Akhnoor)	0.355	0.0097	0.016
7.	Jaswan	1.326	0.0363	0.061
8.	Sagoon	3.517	0.0964	0.161
9.	Surinsar	4.025	0.1103	0.184
10.	Bassi Kalan	3.519	0.0964	0.161
11.	Birpur	1.386	0.0380	0.063
12.	Didyal	1.018	0.0279	0.046
13.	Gho-Brahamana	2.409	0.0660	0.110
14.	Gudwal	5.371	0.1472	0.245
15.	Gho-Rakhwalan	0.808	0.0221	0.037
16.	Kainthpur	5.122	0.1403	0.234
17.	Khairi (Bishna)	4.135	0.1133	0.189
18.	Kamila	0.414	0.0113	0.019
19.	Majua Laxmi	3.820	0.1047	0.174
20.	Patli	2.244	0.0615	0.102
21.	Palli	10.102	0.2768	0.461
22.	Supwal	2.100	0.0575	0.096
23.	Swankha	0.525	0.0144	0.024
24.	Uttarbani	1.787	0.0490	0.082
25.	Dhora	6.021	0.1650	0.275
26.	Penthi (Painthi)	0.221	0.0061	0.010
27.	Channi Marsar	1.755	0.0481	0.080
28.	Mahalshah Kalandrian	10.262	0.2812	0.469
29.	Upperla Kanhal	2.006	0.0550	0.092
30.	Dulma Chak	2.065	0.0566	0.094
31.	Jasath	1.068	0.0293	0.049
32.	Lalachak	5.331	0.1461	0.243
33.	Lokli	0.055	0.0015	0.003
34.	Madun	10.878	0.2980	0.497
35.	Naran	1.045	0.0286	0.048
36.	Nauni	3.547	0.0972	0.162
37.	Nilcha	0.500	0.0137	0.023
38.	Pangdaur	1.406	0.0385	0.064
39.	Patyari II (Kootah area)	2.504	0.0686	0.114
40.	Plura (Phalora)	2.450	0.0671	0.112
41.	Raghuchak	1.188	0.0325	0.054
42.	Sadoh	1.815	0.0497	0.083
43.	Saida	0.966	0.0265	0.044
44.	Sanoora	1.417	0.0388	0.065
45.	Kerian Gandyal II	6.592	0.1806	0.301
46.	Patyari	0.114	0.0031	0.005

The LADD values of water samples given in table 3 of Kathua district varies from 0.0012 to 0.3178  $\mu\text{g kg}^{-1} \text{d}^{-1}$  with average value of 0.0538  $\mu\text{g kg}^{-1} \text{d}^{-1}$  and for Samba district values given in table 4 varies from 0.0015 to 0.2980  $\mu\text{g kg}^{-1} \text{d}^{-1}$  and mean value is 0.0795  $\mu\text{g kg}^{-1} \text{d}^{-1}$ . The limit of the life time daily dose suggested by WHO (2011) is 1.0  $\mu\text{g kg}^{-1} \text{d}^{-1}$ . It can be clearly seen from table 3 & 4 that calculated value of LADD is very less in all the water samples.

Hazard quotient of Uranium was also calculated from the below equation:

$$\text{Hazard Quotient} = \frac{\text{LADD}}{\text{RfD}} \quad (\text{ii})$$

Where RfD is ratio of chronic daily uranium intake to its reference dose. Its value is 0.6  $\mu\text{g kg}^{-1}$ . (18). The Hazard Quotient is also very well within the range of 1.0 suggested by the WHO (2008). The Hazard Quotient given in table 2 varies from 0.0020 to 0.5297 with mean value 0.0986.

### Conclusion

From above studied it can be concluded that uranium is present well within the limits prescribed by WHO in Kathua-Samba district of Jammu and Kashmir. In the hilly areas uranium concentration is very less and water quality is safer than the lower regions. The life time daily dose (LADD) and Hazard quotient is also well within the safe limit as prescribed by World Health Organization.

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