



# International Journal of Engineering Research and Science & Technology

ISSN : 2319-5991  
Vol. 4, No. 1  
February 2015



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## Research Paper

# MEASUREMENT OF URANIUM IN DIFFERENT SEASONS IN GANGES RIVER WATER IN ALLAHABAD REGION

Akash Khare<sup>1</sup>, Prabodha Kumar Meher<sup>2</sup>, Prerna Sharma<sup>2</sup> and Kaushala Prasad Mishra<sup>2\*</sup>

\*Corresponding Author: **Kaushala Prasad Mishra** ✉ [mishra\\_kaushala@rediffmail.com](mailto:mishra_kaushala@rediffmail.com)

Present investigation was carried out to detect and monitor the seasonal variation of uranium in water of Ganges river in Allahabad region. Water samples were collected in different months of pre-monsoon and post-monsoon periods from the designated locations along the flow of river at Allahabad. Samples were processed and measured for uranium level using LED fluorimetric technique. Results showed that pre-monsoon uranium level in Ganges river was found in the range of 3.4 µg/L to 4.09 µg/L. However, post-monsoon values ranged from 3.09 µg/L to 4.85 µg/L. These values are compared with our previous studies on the uranium values that found in hilly region of the Ganges river. The changes in uranium level from mountain regions to plane areas showed an increasing pattern. The measured values are found within the acceptable limit recommended by USEPA and WHO. The study suggests significant seasonal variation in uranium level in Ganges river water along the flow in Allahabad region.

**Keywords:** Uranium, LED fluorimeter, Ganges river, Seasonal variation, Water

## INTRODUCTION

Uranium, a trace heavy metal and radionuclide, generally found in nature within the earth crust, different type of rocks, diverse type of minerals, food materials and also in various water sources (McCal *et al.*, 2009; Carvalho *et al.*, 2007). The radionuclide also come into the environment from various anthropogenic activities like mining, milling, and processing of uranium ores, mineral sands, manufacture of fertilizers, burning of fossils fuels, fallout from past nuclear tests, etc.

Therefore, trace amount of uranium is usually found in most types of geological environmental matrices. However, the concentration of uranium varies from place to place. River water matrix is one of these matrices where trace amount of uranium is found. Uranium present in the river water is mainly due to the leaching out from sources of nature and/or released from human activities. As many rivers originate from rocky area of the hills and mountains, erosion contributes to minerals including uranium in the

<sup>1</sup> Department of Chemistry, Research Center, Nehru Gram Bharati University, Allahabad, UP, India.

<sup>2</sup> Division of Life Sciences, Research Center, Nehru Gram Bharati University, Allahabad, UP, India.

water. In addition, most of the anthropogenic discharges are released into the rivers and thereby increase a greater possibility of contamination by uranium in its water. It is to be noted that the level of uranium in natural water sources within limits is of no concern but increase of uranium level to more than accepted limit poses harm to health when ingested into human body.

Because of environmental and health concerns, monitoring of uranium in river water under various conditions is considered important research problem and reports have appeared in literature on the uranium level in different water sources. For example studies were carried out for natural uranium in subsurface water of Punjab state and in ground water of Hisar in west India (Garg *et al.*, 2014), in ground water of Nalgonda district, Andhra Pradesh (Bridha *et al.*, 2010); uranium in groundwater from western Haryana (Singh *et al.*, 2014). In view of bathing in and drinking of Ganges water by a large population, we have investigated the uranium level in Ganges river water before and after rainy season. Previously our research group has also studied the uranium levels in the Ganges river at hilly regions (Meher *et al.*, 2015 a). It is well-known that a large proportion of population depends on river for clean drinking water and needs plenty of water for farming. Furthermore, a vast ecosystem and a greater portion of food chains are regulated through river water habitat. Evidently, measurement of variations of uranium in river water system as a function of multiple factors is of utmost public health importance. To address public and environmental concerns, present study was undertaken to detect and quantify variations in level of uranium in different seasons at certain designated locations in and around Allahabad in north India which is a pilgrimage and tourist

attraction for billions with estimated population of about 6 millions (Census 2011).

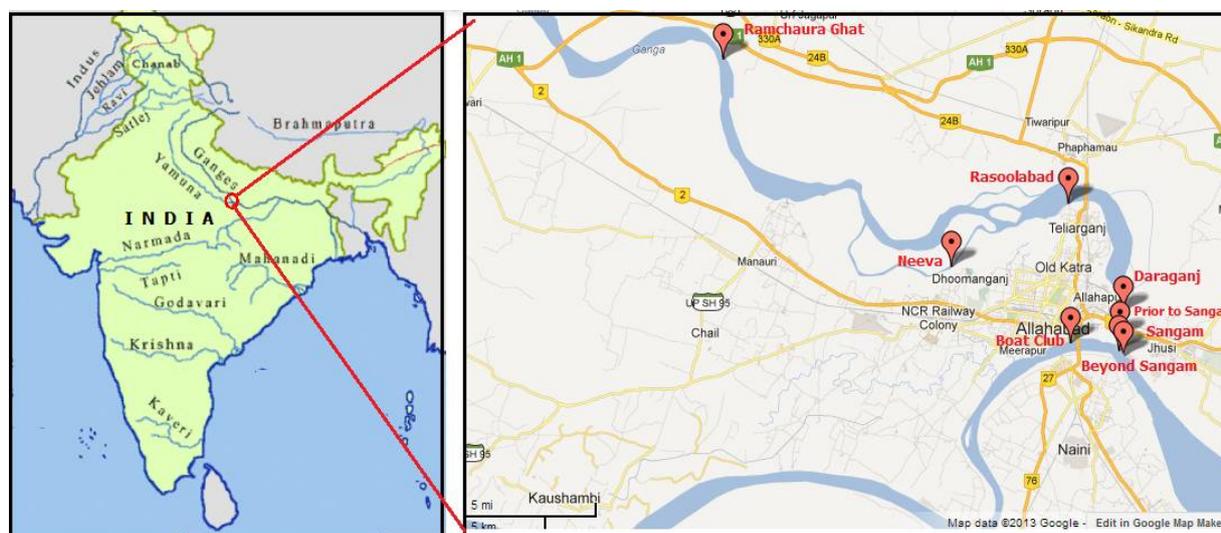
## MATERIALS AND METHODS

Measurements were carried out on water samples from Ganges river along the flow at different locations chosen on the criteria of public activities. The sample collection locations along the Ganges river at Allahabad are shown in the Figure 1. The Geographical Positioning System (GPS) of each sampling point and description of each location are given in Table 1. Water samples were collected at all the designated locations during the prior to monsoon and after monsoon months in year 2012. The pre-monsoon sampling was carried out during the month of March to July. The post-monsoon sampling was carried out during early January and December month of the year 2012.

Water samples were collected in triplicate in polypropylene bottles. The bottles were already washed, previously soaked in 15% (v/v)  $\text{HNO}_3$  for at least 24 h and rinsed with double distilled water. Again, before collecting water samples in the river, bottles were rinsed with the river water itself. Special care was taken to avoid contamination during collection and handling of samples. Water samples were collected from the midstream of river with at least 30 cm depth from the surface. Collected samples were brought to the laboratory, filtered through 0.45 micron nylon filter paper and measurements were carried out immediately on the same day using the standard protocol of the instrument LED Fluorimeter, UA-01 (Quantalase, Indore) described elsewhere (Meher *et al.*, 2015a; Ajay *et al.*, 2011).

The obtained values were tabulated and the statistical analysis was performed using SPSS statistics 17.0 software.

**Figure 1: Sampling Locations on Ganges River at Allahabad**



**Table 1: GPS Locations and Description of Allahabad Sampling Sites**

Location	Latitude	Longitude	Altitude	Description of Site
Ram Chaura Ghat	N25° 34.8647'	N081° 38.7821'	102	A Ghat before entrance of river Ganges in Allahabad
Rasoolabad	N25° 30.1482'	N081° 51.3175'	71	A funeral place at river bank
Shivkuti	N25° 28.1309'	N081° 47.0234'	77	River Ganges after Rasoolabad
Daraganj	N25° 26.7282'	N081° 53.3840'	62	Daraganj, a funeral place at river bank
Prior to Sangam	N25° 25.5564'	N081° 52.9738'	58	Ganges prior to Sangam
Sangam	N25° 25.5836'	N081° 52.9347'	70	Confluence point of River Ganges and Yamuna River called Sangam

## RESULTS AND DISCUSSION

Uranium in the Ganges river water samples collected during the pre-monsoon and post-monsoon periods from different designated locations was measured and analyzed. The values for pre-monsoon are given in the Table 2 and the values obtained from post-monsoon period are given in Table 3. It can be seen from the Table 2 that during March month of pre-monsoon sampling uranium values ranged from 3.16±0.07 µg/L to 4.44±0.60 µg/L and the values

in the month of July ranged from 3.76±0.02 µg/L to 4.32±0.01 µg/L. When we calculated the averages from two month for each designated location the values of pre-monsoon was ranged from 3.48 µg/L to 4.09 µg/L at Sangam and Ramchaura Ghat respectively (Table 2). It was seen that the uranium values at Ramchaura Ghat (4.09 µg/L) are comparatively higher than the values at Sangam (3.48 µg/L). It is worth mentioning that the location Ramchaura ghat is the entry point of Ganges River before Allahabad

**Table 2: Pre-monsoon Values of Uranium in Water of Ganges River at Allahabad**

Locations	Conc. of U ( $\mu\text{g/L}$ ) Date of Collection- 03/03/2012	Conc. of U ( $\mu\text{g/L}$ ) Date of Collection- 02/07/2012	Average Conc. U ( $\mu\text{g/L}$ )
Ramchaura Ghat	3.87 $\pm$ 0.07	4.32 $\pm$ 0.01	4.09 $\pm$ 0.04
Rasoolabad	4.12 $\pm$ 0.74	3.76 $\pm$ 0.02	3.97 $\pm$ 0.38
Shivkuti	4.44 $\pm$ 0.60	3.83 $\pm$ 0.01	3.90 $\pm$ 0.30
Daraganj	3.55 $\pm$ 0.49	NA	3.55 $\pm$ 0.49
Prior to Sangam	3.59 $\pm$ 0.56	4.29 $\pm$ 0.01	3.94 $\pm$ 0.28
Sangam	3.16 $\pm$ 0.07	3.81 $\pm$ 0.01	3.48 $\pm$ 0.04
Note:	NA=not available.		

and Sangam is the place of Confluence of Ganges river with Yamuna river. The place, Sangam is an important pilgrim center in India and a mythological holy place. Many tourist visit to the Sangam for holy dip, according to believes it washouts all the sins (Meher *et al.*, 2015b). The most possible reason for this decrease in uranium concentration may be the dilution factor from water of Yamuna river at Sangam.

The Table 3 describes the post-monsoon values of uranium measurements at the designated locations of Ganges river at Allahabad. It can be seen that in the month of January the uranium values at Allahabad was found to be ranged from 3.10 $\pm$ 0.31  $\mu\text{g/L}$  (Sangam) to 5.05 $\pm$ 0.20  $\mu\text{g/L}$  (Ramchaura Ghat). Similarly, the values ranged from 3.09 $\pm$ 0.06  $\mu\text{g/L}$  to 5.47 $\pm$ 0.56  $\mu\text{g/L}$  during December month. However, the average post-monsoon values were ranged from 3.00  $\mu\text{g/L}$  to 4.85  $\mu\text{g/L}$  in Ganges river at Allahabad. When we look in to observed values of uranium for pre-monsoon and post-monsoon it is well below the acceptable limit (30  $\mu\text{g/L}$ ) recommended by World Health Organization (WHO 2011) and United States Environment

Protection Agency (USEPA 2000). It is worth mentioning that these values of uranium are comparatively higher than the values (1.86  $\mu\text{g/L}$ ) reported earlier by our research group in a long stretch study on Ganges river from Devprayag to Haridwar (Meher *et al.*, 2015a). It can be speculated, the comparatively higher uranium value of uranium at Allahabad in the downstream of Ganges river is a reflection of anthropogenic contribution of uranium to the river water. Moreover, it is noticed that the values reported in the present studies are somewhat higher than the global average of uranium in river water, i.e., 0.3  $\mu\text{g/l}$  (Sarin *et al.*, 1992; Palmer *et al.*, 1993). We did not find any correlation of uranium (present study) with water quality parameters that was reported in our earlier study (Sharma *et al.*, 2014b).

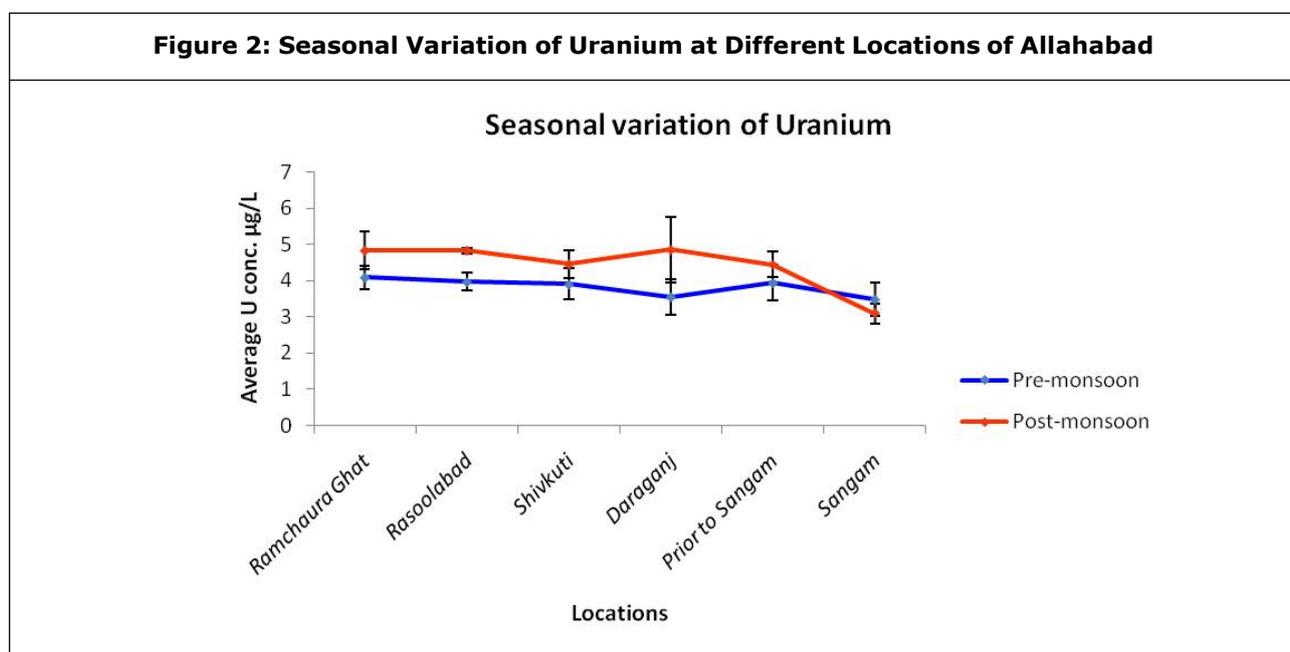
From Figure 2 it can be seen that the post-monsoon values of uranium in each designated locations of Allahabad are comparatively higher than the pre-monsoon values. This is the noteworthy seasonal variation we found from our studies. Apart from other contributing factors, we speculate that during post-monsoon period more

**Table 3: Post-Monsoon Data of Uranium in Water of Ganges River at Allahabad**

Locations	U (ppb)Date of Collection-07/01/2012	U (ppb) Date of Collection-05/12/2012	Average U conc.(ppb)
Ramchaura Ghat	5.05±0.20	4.62 ±0.17	4.83±0.18
Rasoolabad	NA	4.83±0.08	4.83±0.08
Shivkuti	4.22±0.17	4.69±0.37	4.45±0.27
Daraganj	4.24±0.36	5.47±0.56	4.85±0.48
Prior to Sangam	4.58±0.26	4.31±0.40	4.44±0.33
Sangam	3.10±0.31	3.09±0.06	3.09±0.19

Note: NA=not available.

**Figure 2: Seasonal Variation of Uranium at Different Locations of Allahabad**



water from several areas, viz., agricultural land washout are being added to the river system, whereas during pre-monsoon it was comparatively lower in volume addition. Furthermore, It can be seen that the uranium values of Sangam during the post-monsoon (3.09 µg/L) and pre-monsoon (3.48 µg/L) are merely same. This indicates the dilution effect of Yamuna river water at the confluence point. Though, the radiological effect of uranium from the Ganges river water is yet to be determined. Another study

from our research group had reported a  $0.10 \pm 0.012$  mSv.y-1 annual effective dose form the terrestrial gamma radiation in air near the river bank (Sharma *et al.*, 2014a).

### CONCLUSION

Present investigation has evaluated the uranium level and its seasonal variation in the water of Ganges river at Allahabad. It was found that the observed values of uranium in river water are far below the minimum acceptable limit

recommended by the regulatory authorities. However, it is worth mentioning that the observed values are comparatively higher than the world average values of uranium in rivers. Moreover, for the first time our study revealed a significant seasonal variation of uranium in the Ganges river water at Allahabad. Among others factors, it may be a reflection of dilution factor and rate of leaching out by the river water. Compared to the uranium values in river water at hilly region, a markedly increase value of uranium is observed at the Ganges river at plain area. This may be due to contribution from various anthropogenic activities. It is highly instructive to regularly monitor the uranium level in Ganges river in various seasonal conditions to establish pattern of uranium changes and perhaps correlate levels of uranium in the river water with weathering and other environmental conditions.

## ACKNOWLEDGMENT

Mr. Prabodha Kumar Meher and Ms. Purna Sharma acknowledge the financial support of Senior Research Fellowship (SRF) from Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy (DAE), Govt. of India.

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**International Journal of Engineering Research and Science & Technology**

**Hyderabad, INDIA. Ph: +91-09441351700, 09059645577**

**E-mail: editorijerst@gmail.com or editor@ijerst.com**

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