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Post monsoon spatial distribution of uranium in water of Alaknanda and Ganges river

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ABSTRACT

▶ ***Short report***

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***Background*:** Uranium poses both chemical and radiological hazard to the living system. Drinking water from river is one of the major sources of uranium intake. Dissolution of minerals, washout from rain water, rock-water interaction, agricultural run off, and industrial disposals are some of the sources of uranium in river water system. Present study was aimed to determine the uranium in the water Alaknanda and Ganges rivers and its post-monsoon spatial distribution from Nandprayag to Haridwar. ***Materials and Methods*:** River water samples were collected during the post monsoon period in pre-washed polypropylene bottles from the designated locations at both of the rivers. Samples were filtered and analyzed by fluorimetric technique. ***Results*:** The measurements showed the concentration of uranium in water of Alaknanda river varied from 3.05 µg/l to 2.53 µg/l along the downstream sampled locations with a mean value of 2.75 µg/l, whereas in water of Ganges river the concentration varied in the range 1.70 µg/l to 2.00 µg/l with a mean value of 1.86 µg/l. ***Conclusion*:** The average concentration of uranium was found significantly higher (2.75 µg/l) in water of Alaknanda river than in Ganges river the average values (1.86 µg/l) of. However, both the values were far lower than the permissible limits at the sampled locations. The values obtained in present studies were notably higher than that reported elsewhere which seems partly attributable to post monsoon contributing factors.

Keywords: *River, water, uranium, fluorimetric technique.*

INTRODUCTION

Uranium is a widely known lithophilic and naturally occurring heavy trace element found mostly in earth crust and acidic igneous rocks such as granites and soils [1,2] but its concentrations are found variable in soils, rocks, different type of minerals, food materials and water sources [3,4]. Dissolution of minerals, washout from rain water, rock-water interaction, agricultural runoff by use of phosphate fertilizers, the combustion of coal and other fuels and industrial disposals are some of the sources of uranium in river water system.

Once the uranium leaches to the water system, its solubility depends on many factors like pH, temperature, oxidation reduction potential (ORP) [5,6] and total dissolved solids (TDS)[7]. It is well known that radioactive elements cause both radiological and chemical hazard to the living systems [8]. However, in the literature it has been reported that naturally occurring uranium pose more chemical than radiological risk [9,10]. Studies have reported toxicity of uranium in drinking water showing effects to various types of tissues and organ system like kidney [10-11] and in bone tissues [12].

According to the U.S. Environmental Protection Agency (USEPA) and World Health Organization (WHO) chemically, minimum contaminant level (MCL) or guideline limit of for uranium is 30 µg/l [13,14]. Several studies have reported results on uranium concentration level from various drinking water sources. A report has appeared which showed uranium concentration ranging from ≤2 to 644 µg/l in the subsurface of water of Punjab state of India [15] whereas 0.31- 4.92 µg/l of uranium was reported in drinking water of south coast districts of Kerala [16]. The concentrations of uranium in different Indian river water have reported in the literature, a value of 0.09-3.61 µg/l and 0.2 - 1.74 µg/l of uranium was found in Yamuna and Chambal river respectively [17].

Considering the fact that river Ganges is the largest river in India spread over almost 2,525 km long from Gangotri (from Gangotri to Devprayag, it is known as river Bhagirathi) to Bay of Bengal and its basin covers about 8,61,404 km^2 . Alaknanda river is one of the tributaries of Ganges river which joins river Bhagirathi at Devprayag and named afterwards as Ganges river. The Ganges river is one of the major sources of drinking water supply in the country and its water quality is strongly dependent on the environmental conditions. In India, monsoon plays an active role during June-September, which puts in heavy rainfall resulting in erosion and leaching out from rocks and soils [18]. After the monsoon, the post monsoon period dominates about one third period of a calendar year. This signifies a slower flow rate and less dilution factor favoring a stable environmental situation in the river system. Thus, it is important to study the environmental variations after monsoon to determine the prevailing level of uranium in the river. More particularly, this study was aimed to obtain a baseline data for uranium concentration in the Alaknanda and Ganges river water during the post monsoon period.

MATERIALS AND METHODS

Study area

Study area included river Alaknanda and Ganges river of India. Alaknanda river meets the river Bhagirathi at Devprayag and after that it is known as river Ganges. The selected stations for the sampling on river Alaknanda were Nandprayag, Karnprayag and Rudraprayag. Similarly, different locations selected along the Ganges river were Devprayag, Rishikesh and Haridwar (figure 1). Geographical Positioning System (GPS) of each location has been given in

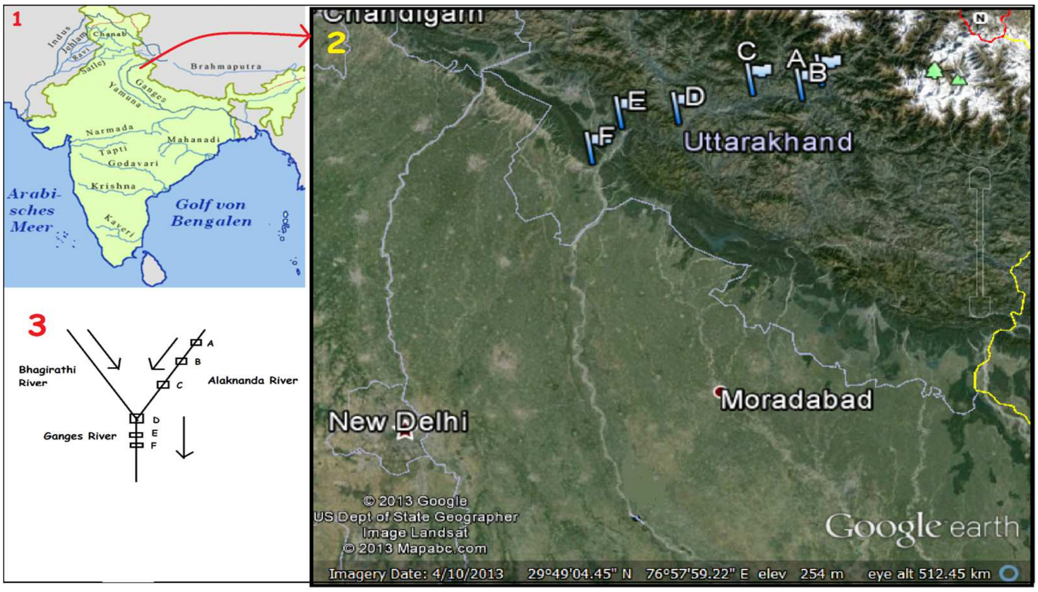

Figure 1. Study area and different sampling locations along Alaknanda and Ganges river.
1) Study area in India. 2) Enlarged view of the study area (image source Google earth). 3) Line diagram of the study area. A- Nandprayag, B-Karnprayag, C-Rudraprayag, D-Devprayag, E-Rishikesh, F-Haridwar, → River flow direction.

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table 1. Sampling was carried out at all the designated locations during the post monsoon period in the month of November 2012.

Methods

Triplicate water samples were collected from the mid stream of river in polypropylene bottles which were previously soaked in 15% (v/v) HNO3 for 24 hr, rinsed with double distilled water and washed with the sample. All samples were filtered through 0.45 micron nylon milipore filter paper and measurements were carried out using the standard protocol of fluorimetric technique [15,19] using LED fluorimeter (Quantalase, Indore, India). All the statistical analysis were performed using SPSS statistics 17.0 software.

RESULTS AND DISCUSSION

The measured concentrations of uranium in samples from Alaknanada and Ganges rivers are given in the table 2. It can be seen that the uranium concentration in Alaknanada river was found to vary from 3.05 to 2.53 µg/l with a mean value of 2.75 µg/l. It is seen that uranium concentration in water samples showed a decreasing trend in downstream of Alaknanda river from Nandprayag to Rudraprayag perhaps suggesting proximity of source upstream of the flow. The observed average value 2.75 µg/l was certainly higher than the earlier reported average value of 1.86 µg/l in Alaknanda river [7]. Among other factors, the observed increased value found in our study may partly be attributed to differences in methods employed by the concerned laboratories e.g. we used fluorimetric method and Sarin et al., employed pre-concentration method. In addition, our measurements were carried out in post-monsoon water sampling (in the month of November) reflecting the role of after rainy season contributing parameters including the dilution factor. It is to be noted that in post monsoon period the water flow rate was slower than in monsoon period (June-September) when flow rate was highest due to rainfalls and snow melting [18]. Our values of uranium seem to reflect a closer real situation and find support from the values reported in geological studies, 4.7 µg/l, from rock samples in Garhwal Himalayan region [19].

Table 2 describes the results of uranium measurement in samples of Ganges river from Devprayag to Haridwar downstream of the flow. It can be seen that in water of Ganges river, uranium concentration ranged from 1.70 to 2.00 µg/l with a mean value of 1.86 µg/l. It is noticed that the values reported from our studies were somewhat higher than the global average of uranium in river water i.e. 0.3 µg/l [7,20]. We find it difficult to offer a logical explanation for this observation but, it needs to be noted that these values were within the MCL and guideline value of 30 µg/l recommended by USEPA and WHO [13,14]. We recognize that continued measurements may be necessary to confirm the observed variations of uranium along the downstream water flow.

Table 1. Sampling locations and Geographical Position System (GPS) of the study area.

River	Locations	Longitute	Lattitute	Altitude (meter)
Alaknanda	Nandprayag	$30^0$19.93' N	79^0 18.97' E	876
Alaknanda	Karnprayag	$30^0$15.79' N	79^0 12.99' E	728
Alaknanda	Rudra Prayag	$30^0$17.28' N	78^0 58.07' E	613
Ganges	Devprayag	$30^0$08.73' N	78^0 35.86' E	468
Ganges	Rishikesh	$30^0$07.34' N	78^0 18.66' E	328
Ganges	Haridwar	$29^0$56.76' N	78^0 09.98' E	289

Figure 2 shows spatial distribution of uranium concentration at all the sampled locations in our studies. It can be seen that uranium concentration at Nandprayag and Haridwar was found to be 3.05±0.09 µg/l and 1.7±0.18 µg/l respectively. These values point to a decreasing trend in uranium concentrations along the downstream of river flow. The observed decreasing trend in the river may be due to additional water streams joining the Alaknanda river as reported elsewhere [18].

RESULTS

Present study has shown a decreasing trend of uranium in the Alaknanda river from Nandprayag to Rudraprayag but these values were slightly higher than the values reported by other authors. The difference in values are ascribable to employed methods and various postmonsoon factors. The average uranium concentration was found significantly higher (2.75 µg/l) in Alaknanda river than of the of Ganges river (1.86 µg/l). It is, however, important to note that measured values ranged within the permissible limits. It appears instructive to monitor uranium on a regular basis in pre and post monsoon conditions to determine alterations in the level of uranium in water of Alaknanda and Ganges river for special variations along the flow.

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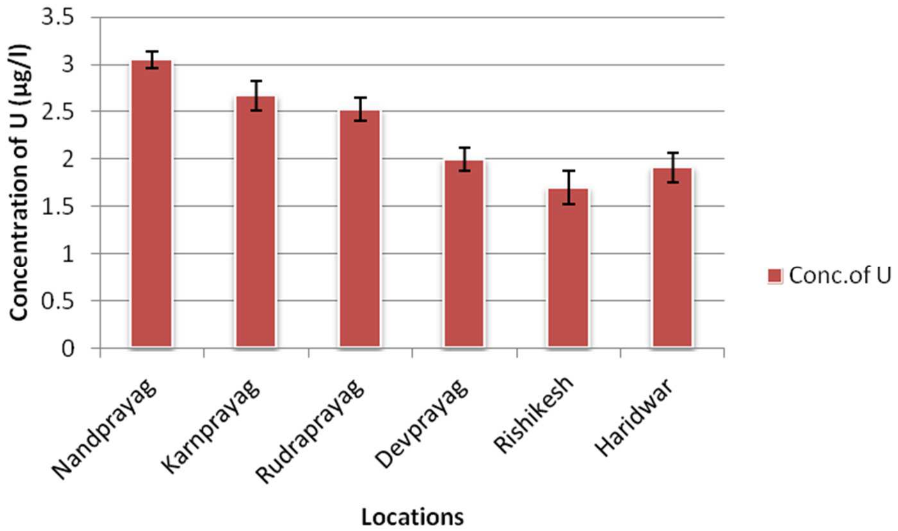

Figure 2. Variation of uranium concentration at different locations of Alaknanda and Ganges river.

Table 2. Uranium concentrations of river water at different locations.

River	Location	Concentration of Uranium (µg/l±SD)
Alaknanada	Nandprayag	3.05±0.09
Alaknanada	Karnprayag	2.67±0.15
Alaknanada	Rudra Prayag	2.53±0.12
Ganges	Devprayag	2.00±0.12
Ganges	Rishikesh	1.70±0.18
Ganges	Haridwar	1.91±0.15

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Conflict of interest: *Declared none*

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